Vol. 26 April, 1933 No. 4

# QUARTERLY

OF THE

# National Fire Protection Association

Annual Subscription $3.00.
Subscriptions are accepted only from members of the Association and are charged as a part of the annual dues. Membership is open to anyone interested.

*Entered as second-class matter December 15, 1928, at the Post Office at Boston, Mass., under act of March 3, 1879.*

60 BATTERYMARCH STREET, BOSTON, MASS.

# National Fire Protection Association

INTERNATIONAL

**Executive Office, 60 Batterymarch Street, Boston, Mass., U. S. A.**

## OFFICERS

SUMNER RHOADES, PRESIDENT
H. L. MINER, FIRST VICE PRESIDENT
GEORGE W. ELLIOTT, SECOND VICE PRESIDENT
ALBERT T. BELL, CHAIRMAN BOARD OF DIRECTORS

FRANKLIN H. WENTWORTH, MANAGING DIRECTOR
PERCY BUGBEE, ASSISTANT MANAGING DIRECTOR
ROBERT S. MOULTON, TECHNICAL SECRETARY

## Organization Members

American Institute of Architects.
American Institute of Electrical Engineers.
American Association of Port Authorities.
American Gas Association.
American Hotel Association.
American Marine Insurance Syndicates.
American Oil Burner Association, Inc.
American Paint and Varnish Manufacturers' Association, Inc.
American Petroleum Institute
American Spice Trade Association.
American Transit Association.
American Water Works Association.
Arizona Equitable Rating Office.
Arkansas Fire Prevention Bureau.
Asphalt Shingle and Roofing Institute.
Associated Factory Mutual Fire Insurance Co's., Inspection Department.
Associated Lumber Mutual Fire Insurance Companies.
Association of Canadian Fire Marshals.
Association of Edison Illuminating Companies.
Association of the Fire Alarm Industry.
Association of Fire Underwriters of Baltimore City.
Association of Mill and Elevator Mutual Insurance Companies.
Board of Fire Underwriters of Allegheny County.
Board of Fire Underwriters of the Pacific.
Board of Fire Underwriters of the Territory of Hawaii.
Board of Underwriters of New York, with which is incorporated the National Board of Marine Underwriters.
Boston Board of Fire Underwriters, Inc.
British Columbia Insurance Underwriters Association, Fire Branch.
Bureau of Explosives.
Canadian Automatic Sprinkler Association.
Canadian Fire Underwriters' Association.
Canadian Manufacturers' Association.
Cast Iron Pipe Research Association.
Central Traction and Lighting Bureau.
Chemical Fire Extinguisher Association, Inc.
Chicago Board of Underwriters.
Chlorine Institute, Inc.
Compressed Gas Manufacturers' Association.
Cotton Insurance Association.
Diesel Engine Manufacturers' Association.
Eastern Underwriters Association.
Eastern Underwriters Inspection Bureau.
Factory Insurance Association.
Factory Mutual Laboratories.
Federation of Mutual Fire Insurance Companies.
Fire Insurance Rating Bureau (Wis.).
Fire Underwriters Inspection Bureau (Minn., N. D., S. D.).
Hollow Metal Manufacturers' Association.
Hydraulic Society.
Idaho Surveying and Rating Bureau.
Illinois Fire Prevention Association.
Illinois Inspection Bureau.
Improved Risk Mutuals.
Indiana Inspection Bureau.
Institute of Makers of Explosives.
Insurance Association of Providence.
International Acetylene Association.
International Association of Fire Fighters.
International Association of Municipal Electricians.
International Brotherhood of Electrical Workers.
Iowa Insurance Service Bureau.
Kansas Inspection Bureau.
Kentucky Actuarial Bureau.
Lightning Rod Manufacturers' Association.
Louisiana Rating and Fire Prevention Bureau.
Manufacturing Chemists' Association of the United States.
Michigan Inspection Bureau.
Middle Department Rating Association.
Mississippi State Rating Bureau.
Missouri Inspection Bureau.
Motion Picture Producers and Distributors of America, Inc.
Mountain States Inspection Bureau.
Mutual Fire Inspection Bureau.
Mutual Fire Insurance Association.
National Association of Credit Men.
National Association of Dyers and Cleaners.
National Association of Engine and Boat Manufacturers, Inc.
National Association of Flat Rolled Steel Manufacturers.
National Association of Insurance Agents.
National Association of Mutual Insurance Companies.
National Association of Safe Manufacturers.
National Automatic Sprinkler Association.
National Board of Fire Underwriters.
National Clean Up and Paint Up Campaign Bureau.
National Electric Light Association.
National Electrical Contractors Association.
National Electrical Manufacturers' Association.
National Lumber Manufacturers' Association.
National Petroleum Association.
Nebraska Inspection Bureau.
New Brunswick Board of Fire Underwriters.
New England Insurance Exchange.
Newfoundland Board of Fire Underwriters.
New Hampshire Board of Underwriters.
New Jersey Schedule Rating Office.
New York Board of Fire Underwriters.
New York Fire Insurance Rating Organization.
Nova Scotia Board of Fire Underwriters.
Ohio Inspection Bureau.
Oil Insurance Association.
Oklahoma Inspection Bureau.
Oregon Insurance Rating Bureau.
Pacific Coast Association of Fire Chiefs.
Philadelphia Fire Underwriters' Association.
Philadelphia Suburban Underwriters' Association.
Pulverized Fuel Equipment Association.
Pyroxylin Plastics Manufacturers' Association.
Railroad Insurance Association.
Railway Fire Protection Association.
Society of Grain Elevator Superintendents of North America.
Society of Motion Picture Engineers.
South-Eastern Underwriters' Association.
St. Louis Fire Prevention Bureau.
Tennessee Inspection Bureau.
Terminal Elevator Grain Merchants' Association.
Texas Inspection Bureau.
Texas State Fire Insurance Department.
Underwriters' Association of the District of Columbia.
Underwriters' Laboratories.
Underwriters' Service Association.
Vacuum Cleaner Manufacturers' Association.
Virginia Insurance Rating Bureau.
Washington Surveying and Rating Bureau.
Western Actuarial Bureau (Fire).
Western Canada Insurance Underwriters' Association.
Western Factory Insurance Association.
Western Sprinkled Risk Association.
Western Underwriters' Association.
West Virginia Fire Underwriters' Association.
West Virginia Inspection Bureau.

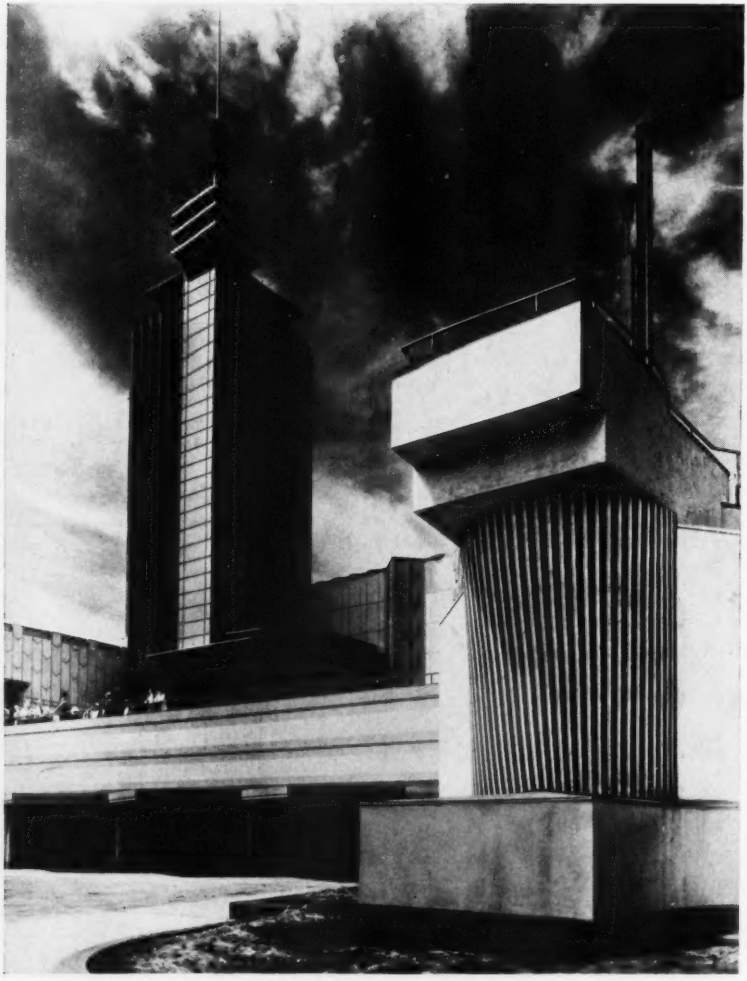
*Over 3,600 Associate Members.*

Printed in U. S. A.

# Table of Contents.


| | |
|---|---|
| Century of Progress Exposition, Chicago | Frontispiece |
| Editorials | 295 |
| Meeting of Board of Directors | 299 |
| A Century of Progress. *J. A. Neale* | 303 |
| U. S. Fire Losses for 1931 and 1932 | 312 |
| Estimating Losses and Determining Values. *A. G. Smith* | 314 |
| Southern California Earthquake | 319 |
| Venting Dust Explosions. *Hylton R. Brown and Richard L. Hanson* | 328 |
| Range Oil Burners. *Fire Record* | 342 |
| Baltimore Armory Fires. *R. W. Neal and C. V. Gordon* | 351 |
| Brewery Fire Record | 358 |
| Gas Holder Explosion, Neunkirchen, Germany | 364 |
| Fires in Which There Was Loss of Life | 368 |
| Annual Sprinkler Tables | 371 |
| Index to Volume XXVI | 384 |


*Reports of fires appearing in the Quarterly are copies of or extracts from written reports forwarded to the Association. This Association, as a body, is not responsible for the statements or opinions of any of its members.*



*Engineering News-Record.*

**Striking architecture is a characteristic of the Century of Progress Exposition. This picture shows the carillon-equipped tower of the Hall of Science, and a rostrum from which 80,000 persons may be addressed at one time.** See article on page 303.

# The Quarterly

Vol. 26 April, 1933 No. 4

**The Thirty-seventh Annual Meeting.** The Milwaukee Convention this year offers the unique opportunity of combining an unusually interesting annual meeting program with an excursion to the Century of Progress Exposition, and an inspection of Underwriters' Laboratories, which many members have not visited since our last meeting in Chicago in 1927.

The decision to meet in the Middle West this year was based on the fact that the Middle Western members have not had a meeting in their home territory for six years, and the selection of Milwaukee was in recognition of the city's outstanding accomplishments in fire prevention. Milwaukee has the advantage of freedom from the outside distractions that affect a meeting in a larger city; the hotel and meeting room facilities are of the best, yet the meeting is near enough to Chicago to take advantage of stimulus of a visit to the Middle Western metropolis. The City of Milwaukee has a distinctive atmosphere, and her citizens a true hospitality that will make the Milwaukee convention, May 29 to June 1, one long to be remembered and an event that no member should miss.

* * * * *

**A Century of Progress?** The Century of Progress Exposition, which opens in Chicago on June 1, has been widely heralded as a visual demonstration of the progress of the past hundred years in the arts and sciences. But the Exposition buildings, while utilizing modern materials of construction, and designed to give ultra modern architectural effects, seem to reflect a philosophy of fire protection more typical of a hundred years ago than of today.

The engineering features of the construction and fire protection of the Exposition are interestingly described in the article on page 303. Unprotected steel wall board and plywood predominate, with light wooden members in extensive concealed spaces. The major buildings are 500 to 1000 ft. or more long, several hundred feet wide in some cases, and extend to heights of 100 ft. or more. The contents will add to the combustible material already present in the structure. There are no fire walls or any other structural provision to

restrict the spread of fire (except in a few tower sections). Mr. C. W. Farrier, Assistant Director of Maintenance and Operation of the Exposition, says in an article in the *Engineering News-Record* March 2, 1933: "No attempt has been made to fireproof the steel in these buildings, on the theory that in case of a major fire it would be more economical to replace the building and its contents." This theory is not limited to structural steel, but is apparently reflected in the general design of the buildings. This theory, applied to a project that supposedly represents the last word in progress, is little short of amazing. It apparently does not consider the fact that it might take months to replace the buildings destroyed by a major fire and that some of the exhibits would be irreplaceable, nor recognize the danger of loss of life by a fire sweeping through a crowded building.

It is apparent to the fire protection engineer that a serious fire might be fatal to the success of the Exposition, with an effect far beyond the dollars and cents value of the physical property destroyed. The fire protection engineer also knows from experience that it is altogether unsafe to rely solely upon means for the prompt detection and extinguishment of incipient fire such as have been provided in the Exposition.

Fortuitous circumstance plays such a large part in the incidence of fire that no opinion can be expressed as to the actual probability of serious fire in the Exposition buildings during the limited period of their occupancy this year, but it does seem most unfortunate that in the design and construction of the buildings advantage has not been taken of the opportunity to set an example in modern methods of fire-safe construction.

* * * * *

**Cigarette Fires.** One encounters people quite frequently who are sceptical regarding cigarettes as a fire cause. There is a columnist on a Philadelphia paper who derives considerable hilarity from the idea. When a local fire which destroys evidence of its origin is attributed to a cigarette it affords him the opportunity for a satirical broadside. An agency which can be responsible for a little fire may logically, however, be responsible for a big one and that cigarettes are piling up loss claims upon the insurance companies is no carefully guarded secret.

A recent bulletin to the companies of the National Board of Fire Underwriters from the executive committee of that organization indicates that the underwriters will probably take definite action of some sort to eliminate payments for cigarette losses. The National Board's bulletin says:

> "The executive committee of the National Board of Fire Underwriters believes that the time has arrived when the companies should instruct their representatives to refuse recognition of such claims on the ground that such payment constitutes a gratuity on the part of those who pay them that is neither justified nor compatible with the provisions of the fire insurance contract."

Surely no reasonable person can object to the insurance companies seeking relief from the claims that are pouring in on them constantly for damages caused by cigarettes to tablecloths, chairs, carpets, upholstered furniture, rugs, table tops, etc. The careless smoker leaves a lighted cigarette on a table, and as a consequence there is usually a hole burned in the tablecloth and the highly polished table is frequently damaged because of scorching.

Companies are constantly being importuned to pay for the refinishing of furniture of one kind or another damaged in this way. Cigarettes thrown or dropped upon carpets, rugs or upholstered furniture will cause almost immediate damage. Practically all of these claims are sent in even though fire does not ensue. It is upon this point that the companies feel justified in specifically excluding liability.

Those who have given special study to this situation say that cigarette losses have become especially serious in recent years since smoking among women has been so widespread.

The figures of the Cook County Loss Bureau relating to cigarette losses in 1932 are interesting, especially when it is considered that they represent only the companies belonging to the Bureau, and that the Bureau's figures are only on Cook County claims. Altogether there were 6205 cigarette losses, amounting to $134,857. Of these 4768 were for $25 or less; 1067 were for from $25 to $50; 288 were for from $50 to $100; 82 were from $100 to $200. In January of this year the Cook County Loss Adjustment Bureau reported 534 cigarette losses amounting to $11,083. These January figures taken together with those of 1932 indicate clearly that losses of this nature are being recorded by the bureau at the rate of over 500 a month.

* * * * *

**Another Success Story.** We have from time to time in the QUARTERLY and other N.F.P.A. publications reported on successful fire prevention activities carried on by municipalities, civic organizations and specific industries. Most of our readers know that "fire prevention pays," but we are all refreshed and stimulated by practical experiences which conclusively demonstrate the soundness of this axiom.

An example that recently came to our attention, and one of the most remarkable, is the experience of the Youngstown Sheet and Tube Company. This company of vast size and with an army of employees, was having a large number of small fires. During the year 1926 a total of 2274 fires were recorded on the properties of the company. Two of the employees of this company took an intense and personal interest in this situation, Mr. W. T. Filmer, Supervisor of Fire Prevention, and Fire Chief Philip J. Harty. These men set out to do two things: first to secure the coöperation of the men in the mills to reduce this excessive number of fires by reducing fire hazards,

and second, to develop the efficiency of the fire brigade of employees. By meetings with the employees of the plant the practical value of fire prevention work to them and to their industry was demonstrated. The value of practical fire prevention in safeguarding life and safeguarding their job was sold to the employees in common sense language. The intense practicability of the campaign is demonstrated by one incident. Considerable oil and grease hazard was found in one section of the plant because of the careless use of these materials. The fire prevention workers pointed out to the superintendent of the mill that a more careful use of oil and grease would not only reduce fire hazard, but save money, and a saving of $583 in one month was effected through this means.

The fire brigade work of the plant was developed to a high degree. Each department has a fire company with a captain, lieutenant and from four to ten members, according to the hazard involved. There is a company for each shift and the companies are drilled at least once a month. An extremely practical method of drills is carried out. The chief of the plant fire brigade hands the company an envelope which contains description of an imaginary fire, which might actually occur in some specific location in the plant. The company then proceeds to get out apparatus and go through such motions as the case requires under the watchful eye of the chief, who comments on their method and offers suggestions after they have finished their drill. By this simple but effective method the men are trained to meet almost any conceivable condition and have become enthusiastic in their work.

The experience under this plan is as follows:

| | |
|---|---|
| 1926 | 2274 fires |
| 1927 | 1127 fires |
| 1928 | 624 fires |
| 1929 | 579 fires |
| 1930 | 254 fires |
| 1931 | 114 fires |
| 1932 | 57 fires |

The number of fires in 1932 was 2½% of the number in 1926. We have seldom seen a more striking example of the results of fire prevention effort.

# Minutes of Meeting of Board of Directors.

## Atlantic City, N. J., January 14, 1933.

### Members Present.

Albert T. Bell, Chairman
Sumner Rhoades, President
George W. Elliott, Vice-President
Harold L. Miner, Vice-President
Frederick T. Moses, Past President
Franklin H. Wentworth, Managing Director
Eugene Arms, Chicago
Frank R. Bradford, Boston
C. H. Haupt, Elizabeth, N. J.
A. H. Kehoe, New York
W. E. Mallalieu, New York
S. D. McComb, New York
C. W. Mowry, Boston
S. L. Nicholson, New York
C. W. Pierce, New York
D. J. Price, Washington
Benjamin Richards, Chicago
A. R. Small, New York
R. E. Vernor, Chicago

### Business Transacted.

1. It was voted to hold the thirty-seventh annual meeting in Milwaukee, the dates to be selected by Chairman Bell and President Rhoades.

2. An informal report on the Field Engineering Service was received.

3. A report on Advertising in the QUARTERLY was received and the appreciative thanks of the Board to Assistant Managing Director Bugbee for his service on this item recorded.

4. The state of the Association's membership was discussed and the following committee appointed to make special efforts to secure members in the mid-western states: Eugene Arms, Benjamin Richards, Richard E. Vernor.

The suggestions of Mr. Haupt concerning invitations to the annual meeting to constituents of organization members, and of Mr. Vernor concerning invitations to be issued by the Milwaukee Chamber of Commerce were referred to the Executive Office.

5. An informal report on the Association's publications was received, including progress in the production of the book on Volunteer Fire Departments endorsed by the Committee on Farm Fire Protection.

6. An oral informative report was presented by Mr. Small concerning the conference on a proposed commercial standard for Oil Storage Tanks called by the Division of Trade Standards of the U. S. Bureau of Standards, which Mr. Small and Mr. Miner had attended as requested by the Board of Directors at its June meeting.

7. It was voted to recommend to the Committee on Articles of Association that it present to the annual meeting a proposed amendment to Article 13 as follows:

*As now:* In order to transact business at any meeting of the Association there shall be at least twenty-five members represented.

*As amended* add to the above: "The votes of members shall be cast by accredited representatives, who shall be recorded with the Secretary before the meeting. The votes of associate members shall be cast by such members individually."

8. It was voted to create a Committee on Technical Committee Procedure as advisory to the Board of Directors with the following scope, the committee to function for one year, action on its continuance to be considered at the January 1934 meeting of the Board:

The Committee on Technical Committee Procedure shall consist of five members to be named by the Chairman of the Board of Directors. It shall elect a Chairman from its membership.

Scope of Jurisdiction:

The Committee on Technical Committee Procedure shall perform such duties as may be assigned to it by the Board of Directors, but shall primarily for purposes of properly advising the Board of Directors, consider the following matters:

1. The desirability and need of setting up new technical committees.
2. The desirability and need of initiating new projects by existing technical committees.
3. The personnel of technical committees, including increases and changes in personnel.
4. A review of the scope of present technical committees with the end in view of preventing overlapping of activities and stating precisely the range of individual committee activities.
5. The advisability of discontinuing unnecessary and inactive technical committees.
6. The acceptability of emergency revisions of regulations, standards or good practice requirements submitted by technical committees.

When the committee has for consideration such emergency revisions, the chairman of the technical committee in question shall serve ex-officio as a member of the Committee on Technical Committee Procedure.

By "emergency revisions" as above referred to is meant important changes in any given regulations, standards or good practice requirements made necessary by emergencies occurring at a time of the year such as to involve serious and possibly costly delay, if action is deferred until the spring convention. Under this procedure, an organization desiring such a change should apply to the Executive Office, submitting with the request all data relating to the need for such a change. The matter will then be referred to the technical committee, and the findings of the latter submitted to the Committee on Technical Committee Procedure, which will then report its findings to the Board of Directors.

7. The desirability and need of submitting any National Fire Protection Association regulation, standard or good practice requirement to the American Standards Association for adoption.

When the committee has for consideration such matters of adoption by the American Standards Association, the Chairman of the National Fire Protection Association technical committee in question shall serve ex-officio as a member of the Committee on Technical Committee Procedure.

Chairman Bell appointed the following five directors to constitute this committee: Geo. W. Elliott, C. H. Haupt, C. W. Mowry, C. W. Pierce and A. R. Small.

9. It was voted that the N.F.P.A. Regulations on Blower and Exhaust Systems be submitted to the American Standards Association for adoption as an existing standard.

10. It was voted to accept the invitation of the American Standards Association to appoint a representative upon a Sectional Committee for developing a Ventilation Code with the American Society of Heating and Ventilating Engineers as sponsor. (This project, while primarily a health code, may deal incidentally with matters already covered by the N.F.P.A. Regulations on Blower and Exhaust Systems.)

11. No action was taken on the invitation from the American Gas Association to appoint a representative upon a Sectional Committee of the American Standards Association covering Project Z-21, rules governing the installation of gas appliances, for which the American Gas Association is sponsor.

12. It was voted to approve the creation of a Volunteer Firemen's Section of the N.F.P.A. and member William Draper Brinckloe and Assistant Managing Director Bugbee were authorized to initiate and develop the project.

13. It was voted inexpedient for the N.F.P.A. to be involved directly or indirectly in the offering of rewards for the conviction of incendiaries.

The following resolution presented by Director D. J. Price, Chairman of the Committee on Farm Fire Protection, was adopted:

Resolution.

"While the interest of all members of the National Fire Protection Association is in harmony with the endeavor to lessen farm fire waste, the Board of Directors feels that arson as a cause of farm fires is directly one of fraud on the insuring company. Although the Board has taken positive action to the effect that the Association cannot participate in any manner in offering rewards of any kind, the Board desires to encourage any legitimate activities that relate to the reduction of farm fire losses."

14. Director Benjamin Richards, Chairman, Committee on Manufacturing Risks and Special Hazards, reported progress in the consideration of proposed regulations for spark arresters for stacks of boilers using wood waste as fuel, which had been suggested in a communication referred to this committee.

15. Applications from two members for appointment to the Committee on Signaling Systems and Thermostats were laid on the table.

16. The Committee on Fumigation Hazards was authorized to finance by means of voluntary subscriptions research work on fumigants as applied to grain; such work to be done by Underwriters' Laboratories. The committee was also authorized to include the use of heat in the scope of its project and to refer the matter of high test sprinkler heads in connection therewith to the Committee on Automatic Sprinklers.

17. The program of work outlined for the Committee on Building Construction and the appointment of its new Chairman, Mr. R. C. Loughead, were confirmed.

This committee will act in an advisory capacity to the Association and to other committees, reporting on current trends and new types of construction and making recommendations thereon for the information and guidance of the Association. Other committees may refer to this committee any special problems on building construction matters. The committee will continue to have jurisdiction over standards covering specific features of building construction such as the following items which are now listed on the committee program.

Roof Openings, Cornices and Gutters, revision of 1916 standard.

Construction to Reduce Water Damage, new pamphlet proposed to bring up to date standards on scuppers which appeared in the old pamphlet on Mill Construction, and to include material on waterproofing of floors.

Private Residences (Report adopted 1925).

Standard Industrial Buildings (Report adopted 1929).

The committee plans to prepare a popular brochure designed to interpret to the layman the basic principles of fire-resistive construction (without setting up formal standards therefor), explaining the reasons for the fundamental requirements, including height and area limitations, fire stopping, protection of vertical and horizontal openings, exposure, etc.

18. It was voted to approve the revised status and personnel of the Committee on Fireproofing Processes.

This committee, originally an advisory committee to the Board of Directors, becomes a standing technical committee of the Association, operating in a manner similar to other committees. The personnel is shown in the 1932 Year Book. In addition to the contacts with various organizations provided by the present personnel, it is planned to secure appropriate contact with the American Society for Testing Materials, which has a committee dealing with test methods for fireproofed wood. As the industry is not organized it has not been deemed expedient at the present time to have on the committee any representatives of the manufacturers of fireproofed wood or fireproofing materials. It is expected, however, that the committee will maintain suitable contact with the manufacturers when reports on subjects affecting their interests are made.

This will be largely a coördinating and advisory committee. The scope will embrace fireproofing processes, not only for wood, but for textiles and other materials. In addition to making informative reports on the status and prospects for these processes the committee may deal with performance standards for various treated materials.

19. It was voted to extend the scope of the Committee on Zoning to include the field of city planning and that the name of the committee be changed to "City Planning and Zoning."

20. COMMITTEE REVISIONS. It was voted to approve the revised committee personnel shown in the 1932 Year Book, which incorporates the appointments made by the President in accordance with the authorization of the Board at its last meeting, and to confirm the following subsequent appointments:

**Building Construction:**

H. F. Badger, Board of Fire Underwriters of the Pacific.

David H. Merrill, Pacific Coast Building Officials Conference.

P. R. Wesley (replacing J. F. Templin), Western Actuarial Bureau.

**Electrical:**

R. J. Moran (replacing M. B. Gleeson), Underwriters' Association of the Middle Department.

**Electric Railway Car Houses and Cars:**

O. A. Frederickson (replacing R. W. E. Moore), National Electrical Mfg. Association.

A. D. McWhorter (replacing E. J. Jonas), American Transit Association.

H. S. Williams (replacing D. Ernest Frame), American Transit Association.

**Garages:**

P. R. Wesley (replacing J. F. Templin), Western Actuarial Bureau.

**Marine:**

Sir James French, Lloyds Register of Shipping.

**Manufacturing Risks and Special Hazards:**

P. R. Wesley (replacing J. F. Templin), Western Actuarial Bureau.

R. L. Rumbaugh (replacing J. Harvey Patterson), Western Sprinkled Risk Association.

21. The project of the Marine Committee to develop a brochure on ship fire protection was approved.

22. The Advisory Committee was invited to consider the subject of the use of special N.F.P.A. published material in the solicitation of new members.

# A Century of Progress.*

By J. A. Neale,

Chicago Board of Underwriters (Member N.F.P.A.)

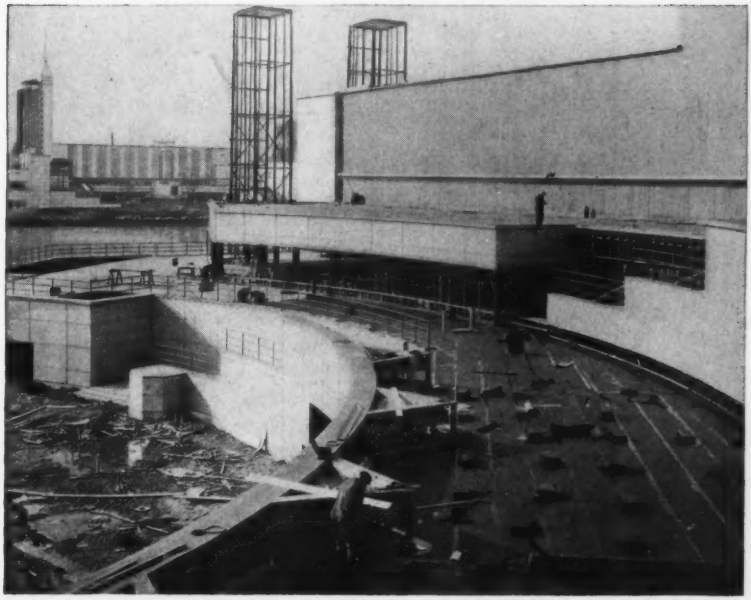
The 1933 Century of Progress Exposition at Chicago occupies a narrow strip of land about three miles long and an adjacent artificial 82-acre island about opposite the center of Chicago on Lake Michigan. This land is leased from the South Park Board for the period of the Fair. It is state property and the municipal regulations of the City of Chicago, governing building construction, electric wiring, fire protection, etc., do not apply. The district is technically outside of municipal fire and police protection, but the Chicago Fire Department has coöperated with the Century of Progress very fully by loaning equipment and arranging to respond to alarms as though the Fair were within the municipality.

When plans were first being made over three years ago it was thought that all the major buildings would be of incombustible construction—probably unprotected metal of the "unit construction" type, which would permit rapid erection and which would have considerable salvage value. Based on this construction a water supply was planned which would provide a fire flow of 10,000 gallons per minute above maximum domestic consumption, having large connections with the city mains to provide an emergency supply in case of accident to the Fair's pumping station. A private fire department was to be provided, consisting of 5 pumpers, 1 city service truck, 1 aerial truck, to be backed up by the Chicago Department, including the fire boats.

This protection was to be installed as construction progressed so that a fair degree of protection would always be available.

*See editorial, page 295; also Frontispiece.—Ed.

View during the construction of the Agricultural Building, showing wooden joists and decking supported on steel truss ribs.



**Typical view, showing construction of Electrical Building. The roof deck in the foreground is asphalt tiling laid on plywood.**

Unfortunately economic conditions forced a decided revision of plans and the degree of protection provided is considerably less than was originally contemplated, and at the same time deviations from the planned type of construction also affect the protection adversely.

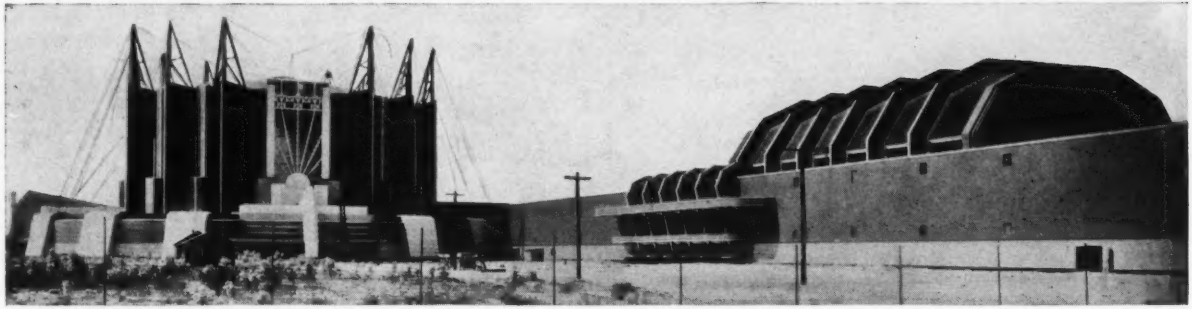
### Building Construction.

The first two buildings erected, the Administration Building and the Travel and Transport Building, conform to the type of construction originally planned. They are of light, mainly incombustible construction, consisting of metal units, fire protected with incombustible wall board.

With the exception of the Administration Building all structures are windowless, of extremely large area, undivided by fire walls. They are not intended for permanency, and are not readily capable of being heated.

The buildings other than the two above mentioned, have steel frames, wood studs and walls sheathed with wall board; floors consist of wood veneer panels on expanded metal joists, ceiled on the under side with incombustible wall board. Roofs are, in general, of wood.

An important exception to the above is the Hall of Science, which is sheathed with wood veneer panels.



The Travel and Transport Building.

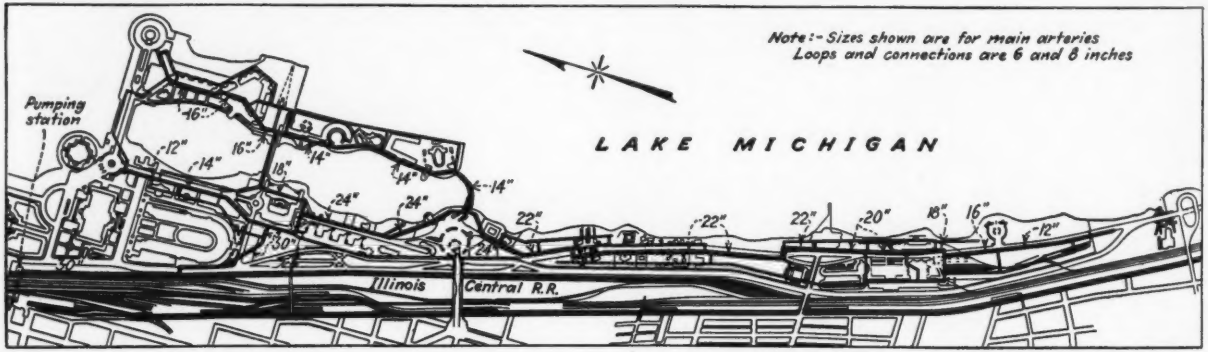



Diagram of Water Distribution System.

Unusual architectural effects have been obtained which in many cases form concealed spaces in walls, ceilings and roofs of considerable extent and combustibility. In general these spaces are not fire stopped.

The smaller buildings of the concessionaires are mostly of frame construction. In most cases ample clear spaces separate the structures.

High towers form an important architectural feature; these towers in general are under 200 feet in height, are not occupied for any purpose and are equipped with automatic sprinklers, supplied by booster pumps which are operated by an automatic fire alarm system.

### Inside Fire Protection.

The majority of the main buildings are provided with supervised watch service and automatic fire alarm. Water barrels and pails, hand pumps and standpipes and small hose are installed throughout. The underground water mains which were installed in the Hall of Science building, to supply the standpipe and hose system, were of spiral riveted steel construction coated with tar. During the period of construction these mains corroded so badly that when tested they were found to be unusable. This piping was abandoned and replaced with mains of the same construction suspended from the first floor ceiling. The same situation occurred in the Electrical group and was remedied in the same manner.

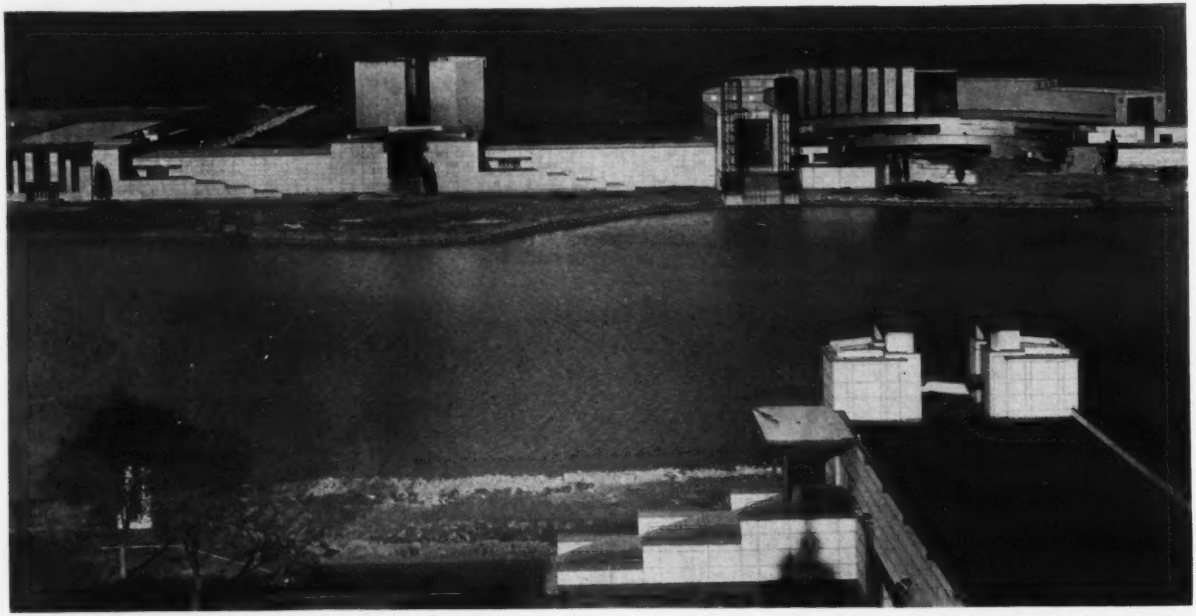
Transformer vaults which are located in many buildings are equipped with dry chemical type extinguishers.

### Water Supply.

A pumping station is constructed near the north end of the property, taking suction from the City of Chicago tunnel, which conveys water from a crib five miles out in the lake to two city pumping stations. Three 10-million gallon per day, 75 pound, electrically driven centrifugal pumps will discharge into the underground system, which is a partially looped layout using welded steel pipe, grading in size from 30 inches down. This system is designed to supply 5000 gallons per minute fire flow in addition to the assumed maximum domestic demand at a pressure of not less than 20 pounds at the weakest point in the system. Hydrants are located at suitable intervals and the system is well gated, but could be crippled by a single break occurring in any of several places. No large size emergency connection to the Chicago system, originally planned, is installed. Water will be chlorinated at the pumps as is the city practice.

Until the pumping station was put in service a 6-inch connection to the city system providing about 650 gallons per minute was used, which will be retained as an emergency supply.

On account of storm protection at the shore line, it is impossible for pumpers to take suction from the lake or the lagoon, except where ramps



Looking across the lagoon from the Hall of Science to the Electrical Group on Northerly Island. These buildings, housing exhibits of radio, telephone, telegraph and electric-power utilization, are 1200 ft. long and 300 ft. wide. The two center pylons are to resemble massed, illuminated trees.

have been provided for that purpose, which has been done in the vicinity of the Hall of Science, the Electrical Group and the Administration Building.

### Fire Department.

The Century of Progress fire department will consist, when completed, of a 1000-gallon per minute pumper and a 1000-gallon quadruple combination ladder truck, chemical, hose wagon and pumper. This equipment will be housed in a one-story frame house west of the General Exhibits Group and will be manned by a paid department.

The City of Chicago has assigned phantom fire alarm boxes to the area and will back up the private department on all calls. On account of the distance to be traveled it is estimated that about 12 minutes would elapse between the receipt of an alarm and the time that the city companies could get in operation. The local department will, of course, be able to respond much sooner.

### Fire Alarm System.

There are no city fire alarm boxes in the area. All principal buildings are well equipped with central station manual fire alarm boxes and it is expected that additional boxes of this type will be conspicuously located throughout the grounds. Alarms received from this source will be transmitted by the central station to the Fair Fire Department by direct wire and also to the Chicago Fire Department. Telephone alarms received by the Fair Fire Department will be transmitted to the City Department, unless the fire is known to be of a very minor nature and not in a building. It was originally planned to have a central station within the grounds; this will not be done, but signals will be received and handled at the LaSalle Street Central Station.

### Inspections.

Nearly as soon as construction began, the World's Fair Insurance Pool provided the services of Chief McDonnell, formerly Chief of the Bureau of Fire Prevention, City of Chicago, to the Fair as Fire Marshal. He is now Chief of the Fair Fire Department. It has been realized that diligent inspection work to eliminate the causes of fires is especially necessary, considering the nature of the construction and the degree of fire protection provided, and such inspections are being made by the department.

### Hazards.

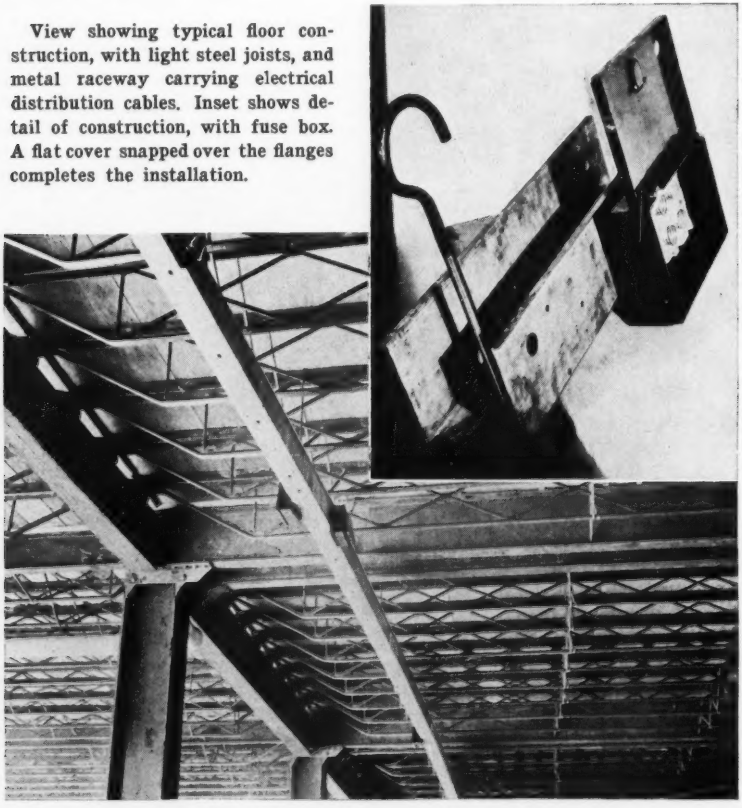
The hazards involved are varied; many exhibits will involve no unusual hazards, but the exhibits of some concessionaires in their buildings will involve the hazards of auto assembling, body building and anti-knock gasoline blending and testing. The high degree of cleanliness necessary where the process is on exhibition, however, should reduce the hazards considerably. A period of severe hazard will exist just prior to the opening of the Fair when

the hazards incident to unpacking and setting up exhibits and decorating display spaces will be coupled with temporary and probably unauthorized lighting and heating arrangements.

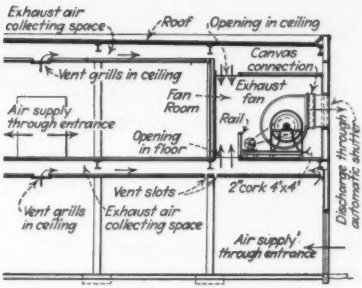
### Electrical Installation.

A tremendous amount of electrical energy will be needed. The windowless buildings encourage novel lighting arrangements, and unusual exterior illumination is an important architectural feature.

High tension service is 4000 volts run underground from the main substation at the Stadium in wooden ducts to the various transformer vaults located in the more important buildings. The cables are 3 conductor, lead covered cambric and rubber, ranging from 2/0 to 350,000 C.M. The transformer vaults are constructed of hollow concrete block and are practically standard in most features.



**View showing typical floor construction, with light steel joists, and metal raceway carrying electrical distribution cables. Inset shows detail of construction, with fuse box. A flat cover snapped over the flanges completes the installation.**




**Typical ventilating system, utilizing concealed spaces in floors and roofs for collecting exhaust air.**

Standard type oil cooled transformers are employed, mostly in 200 K.V.A. units, connected in 3 and 6 transformer banks. The distribution network is 3 phase 4 wire, 208/120 volt. The fourth wire or grounding medium is created in the transformer vault by burying a copper plate 4 x 4 feet in charcoal in a wet location.

In the transformer room a large switchboard of wood plank or sheet metal on angle iron framework is provided for 10 to 30 three-pole fused switches, ranging in size from 50 to 300 amps., and each enclosed in approved metal cabinets providing practically a dead front switchboard in all cases. These switches serve the numerous circuits in the metal troughs which are run throughout the building and all the distributing centers.

The principal methods of current distribution are with large metal troughing, all sizes of conduit for feeders and open knob, tube and cleat work for the branch circuits. Small 4 circuit metal fuse cabinets are mounted on the sides of the metal troughs for the branch circuits lighting for the exhibit spaces. This scheme makes a very flexible lighting medium which can be changed at will. Plug fuses of 20 amp. capacity are employed throughout.

Practically all the lighting will be concealed. This will be accomplished by using concealed Neon tube and cove lighting. The ceiling outlets will also be concealed.

---

NOTE: The illustrations with this article are all furnished by the courtesy of the *Engineering News-Record.*

# U. S. Fire Losses for 1931 and 1932.

### Compiled by National Board of Fire Underwriters.

The United States fire losses for 1931 were $451,643,866, according to the final figures of the Actuarial Bureau of the National Board of Fire Underwriters published in the winter issue of *Safeguarding America Against Fire.* This figure supersedes the previous estimate of the 1931 fire loss made by the National Board as published in the July, 1932, QUARTERLY, page 20.

### American Fire Losses Compared, 1930-1931.

| Causes | Recorded Loss 1930 | 1931 |
|---|---|---|
| Matches—Smoking | $32,016,756 | $28,174,240 |
| Defective Chimneys and Flues | 20,851,675 | 20,736,837 |
| Stoves, Furnaces, Boilers and Their Pipes | 19,915,501 | 14,726,047 |
| Electricity | 15,972,125 | 13,667,186 |
| Sparks on Roofs | 13,149,816 | 11,271,709 |
| Petroleum and Its Products | 11,440,570 | 10,550,319 |
| Spontaneous Combustion | 13,852,979 | 11,055,629 |
| Lightning | 8,323,422 | 7,408,414 |
| Hot Ashes and Coals | 5,100,365 | 4,528,071 |
| Open Lights | 3,439,833 | 2,280,925 |
| Sparks from Combustion | 2,754,966 | 1,560,773 |
| Sparks from Machinery | 4,538,024 | 4,550,969 |
| Miscellaneous Known Causes | 4,085,074 | 2,169,062 |
| Rubbish and Litter | 1,557,427 | 1,283,290 |
| Gas, Natural and Artificial | 3,073,431 | 2,335,294 |
| Incendiarism | 7,894,075 | 16,664,881 |
| Ignition of Hot Grease, Tar, Wax, Asphalt etc. | 2,243,447 | 1,670,899 |
| Explosions | 2,896,823 | 1,420,000 |
| Fireworks, Firecrackers, etc. | 775,517 | 490,779 |
| Steam and Hot Water Pipes | 127,775 | 244,460 |
| *Exposure (including Conflagrations) | 35,486,885 | 30,621,786 |
| Unknown Cause | 192,088,013 | 173,903,523 |
| Total | $401,584,499 | $361,315,093 |
| 25% to Cover Unreported Losses | 100,396,124 | 90,328,773 |
| | $501,980,623 | $451,643,866 |

### 1932 Losses.

Fire losses for 1932 are estimated by the National Board at $442,143,311. This figure, determined since the the publication of the January QUARTERLY, is approximately 0.3% more than the preliminary estimate which appeared in that issue. (See QUARTERLY, January, 1933, page 208.) The original estimate was based on estimates by the National Board for the eleven months ended

*Losses due to spreading of fires originating from various causes.

November 30, 1932, with a figure for December based on the experience of previous years. The following are the monthly totals for 1932 released by the National Board:

| | | | | | |
|---|---|---|---|---|---|
| January ..... | $39,224,783 | May ..... | $39,270,524 | September ... | $30,972,318 |
| February .... | 39,824,622 | June ..... | 34,338,670 | October ..... | 30,734,458 |
| March ..... | 49,189,124 | July ..... | 32,982,434 | November ... | 31,167,708 |
| April ..... | 43,822,233 | August ..... | 31,425,931 | December .... | 39,190,506 |
| | | | | Total... | $442,143,311 |

## Comparison of U. S. Fire Losses, 1930-1931, by States.

| State | Recorded Loss 1930 | Recorded Loss 1931 | State | Recorded Loss 1930 | Recorded Loss 1931 |
|---|---|---|---|---|---|
| Alabama ..... | $5,962,586 | $6,782,694 | New Hampshire | $4,447,026 | $3,076,774 |
| Arizona ..... | 5,831,502 | 5,466,905 | New Jersey.... | 18,353,785 | 15,188,425 |
| Arkansas ..... | 1,088,019 | 1,082,451 | New Mexico... | 728,536 | 612,571 |
| California .... | 18,052,877 | 17,781,006 | New York..... | 50,317,199 | 46,200,677 |
| Colorado ..... | 2,050,955 | 1,561,675 | North Carolina | 9,004,906 | 9,130,631 |
| Connecticut .. | 4,156,672 | 4,153,270 | North Dakota. | 2,393,947 | 2,775,414 |
| Delaware ..... | 636,942 | 654,995 | Ohio ..... | 18,305,234 | 16,009,787 |
| Dist. Columbia | 883,643 | 410,564 | Oklahoma .... | 6,615,454 | 6,174,770 |
| Florida ..... | 4,757,326 | 4,720,253 | Oregon ..... | 4,001,662 | 4,118,357 |
| Georgia ..... | 8,140,902 | 8,781,180 | Pennsylvania... | 25,578,767 | 22,030,880 |
| Idaho ..... | 1,337,283 | 1,450,770 | Rhode Island.. | 2,586,536 | 2,290,725 |
| Illinois ..... | 30,167,109 | 20,406,601 | South Carolina | 5,126,438 | 5,152,367 |
| Indiana ..... | 10,824,880 | 6,775,245 | South Dakota. | 1,389,375 | 1,832,612 |
| Iowa ..... | 5,936,944 | 5,824,617 | Tennessee .... | 9,432,630 | 8,721,442 |
| Kansas ..... | 4,806,647 | 3,924,103 | Texas ..... | 19,569,922 | 19,563,091 |
| Kentucky .... | 7,907,152 | 6,514,289 | Utah ..... | 810,677 | 1,033,030 |
| Louisiana .... | 7,462,184 | 6,474,758 | Vermont ..... | 925,965 | 998,489 |
| Maine ..... | 3,625,533 | 3,743,792 | Virginia ..... | 6,517,172 | 7,887,856 |
| Maryland .... | 5,010,309 | 3,810,500 | Washington ... | 6,942,553 | 6,914,982 |
| Massachusetts.. | 21,376,410 | 18,543,157 | West Virginia.. | 4,746,470 | 4,668,281 |
| Michigan ..... | 13,217,485 | 11,317,550 | Wisconsin .... | 7,859,719 | 6,556,334 |
| Minnesota .... | 7,241,262 | 6,551,403 | Wyoming .... | 832,872 | 475,478 |
| Mississippi ... | 6,796,855 | 6,972,806 | United States.. | $401,584,499 | $361,315,093 |
| Missouri ..... | 12,753,838 | 11,063,555 | 25% for Unreported Losses | 100,396,124 | 90,328,773 |
| Montana ..... | 1,704,319 | 1,955,889 | Total... | $501,980,623 | $451,643,866 |
| Nebraska ..... | 3,113,421 | 2,922,261 | | | |
| Nevada ..... | 254,599 | 255,831 | | | |

## Annual Fire Losses in the United States from 1912 to 1932 Inclusive.

| | | | |
|---|---|---|---|
| 1912..... | $206,438,900 | 1923..... | $535,372,782 |
| 1913..... | 203,763,550 | 1924..... | 549,062,124 |
| 1914..... | 221,439,350 | 1925..... | 559,418,184 |
| 1915..... | 172,033,200 | 1926..... | 560,548,624 |
| 1916..... | 258,377,952 | 1927..... | 478,245,620 |
| 1917..... | 289,535,050 | 1928..... | 464,607,102 |
| 1918..... | 353,878,876 | 1929..... | 459,445,778 |
| 1919..... | 320,540,399 | 1930..... | 501,980,623 |
| 1920..... | 447,886,677 | 1931..... | 451,643,866 |
| 1921..... | 495,406,012 | 1932 (preliminary est.).... | 442,143,311 |
| 1922..... | 506,541,001 | | |

# Estimating Losses and Determining Values.

By A. G. Smith (Member N.F.P.A.),
Chief Engineer, The Travelers Fire Insurance Co.

The estimating of fire losses and the determination of property values as a basis for such estimates present certain inherent difficulties to fire department and other public officials upon whom rests the responsibility for establishing property losses subsequent to a fire. Those who examine buildings damaged by fire find it necessary to use either some familiar rule, valuation table or appraiser's manual, or rely entirely upon their own judgment based on years of experience.

Methods of determining destroyed values are not uniform in different parts of the country. This lack of uniformity tends, to some extent, to hamper the establishment of accurate statistical records of fire losses and subjects comparisons of fire losses between one community and another to possible distortion. It is not the intention here to suggest or provide a uniform procedure of estimating property losses or create a universal means of establishing values for existing property but, rather, to discuss briefly some of the various methods of estimating and to offer a general opinion as to their worth.

The value of a building for insurance purposes is its fair value to the owner for the purpose for which it is being used and not necessarily what it would sell for. This value, however, must not be in excess of its cost to reproduce new, less depreciation.

The plan of insurance is that no one may benefit by a loss. Some persons insure their buildings for an amount equal to replacement cost in the belief that in the event of total loss the insuring companies will give them a new building for an old one, or its equivalent in cash. Such, however, is seldom the case unless a state law requires the insurance companies to pay the face value of the policy in the event of total loss.

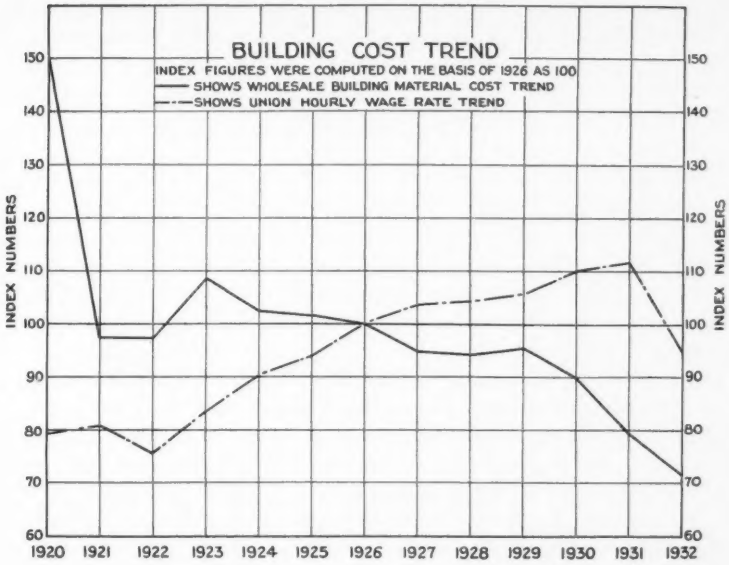
It is well for the owner to understand the following insurance stipulations:

> "The insurance company shall not be liable beyond the actual cash value of the property at the time any loss or damage occurs and the loss or damage shall be ascertained or estimated according to such actual cash value, with proper deduction for depreciation, however caused."

Through the test of a number of fire loss settlements actual cash value has come to be the cost to replace new, less depreciation caused through age, physical wear, obsolescence and inadequacy.

## Building Cost Trend.

During the past two or three years building costs have been directly affected by falling commodity prices and decreased employment. The accompanying graph generally illustrates the country-wide average trend of building




costs from 1920 to the present time. For the sake of consistency, average wholesale building costs and average union hourly wage rates for the various building trades have been used.

It will be appreciated that material and labor costs vary in one section of the country compared with another, and between the city and the small community, depending upon local resources for materials and labor. Further, while union wages may not be maintained in some sections at the present time they are being so maintained in others, consequently the graph for union hourly wage rate is subject to variation due to local conditions.

As a matter of general interest, it may be noted that residential country-wide construction costs averaged in 1931-1932 about 37.3% for labor plus 62.7% for materials. For non-residential buildings, costs are represented by 35.7% for labor in addition to 64.3% for materials.

### Estimating Building Values.

There are various means of estimating the values of buildings—itemized construction details, cubic foot, square foot, or the rough quantity and unit method. Whatever rules, scales or tables are used, regardless of how complete they may seem to be and even if obtained from an authoritative source, they must be applied with judgment by a trained mind in order to produce uniform values. Each property is a problem in itself and there are no formulas that can be mechanically applied and result in thoroughly equitable values.

Itemizing details of materials and labor costs is recognized as the ideal and unquestionably the preferred method. This procedure is usually followed by expert appraisers who make it a business to obtain all the essential details necessary to derive a consistent replacement value of an existing building. The cubic foot or superficial square foot methods are reasonably satisfactory for comparative estimating purposes for many types of construction. The cubic foot method is most generally used. Schedules to determine quantity and building unit value of factors (rough estimation of quantity of materials and costs per room, etc., on a comparative basis) are subject to decided variations and possible discrepancies due to many items which may largely influence the final estimation of replacement value. Such items are variety of design, quality of materials used, workmanship, architectural details, shape, size and numerous other variable factors.

In estimating small or partial building losses the fire department official must be familiar with local material and building costs before he can accurately estimate the amount of destroyed value subject to replacement. By way of example, take the case of a mercantile building involved in a fire which destroyed a portion of the floors, and damaged to some extent plumbing, electric conduits, wood trim, ceilings and brick construction. In order to determine the extent of loss with reasonable accuracy it would be necessary for the fire chief or other officials to know the cost of the materials required for replacement together with the local cost of labor to install these materials.

If the fire department official decided this method of estimating was impractical in view of the condition of the damaged property, he might estimate percentage of loss to the building and deduct this value from the total value of the building after deriving the present day replacement value of the entire structure.

### Cubic Foot Method of Estimating.

In view of the fact that the cubic foot method is widely used in determining for comparative purposes replacement costs of existing building structures, it appears appropriate to discuss this method at greater length.

The values determined through the cubic foot method generally represent the lowest cost. The procedure usually followed does not include decorations, ornamentation, extensive heating or ventilating systems or unusually complicated design, financing costs, architect's fees, etc. These and other special features may be calculated separately as additional items.

It should be borne in mind that usually the smaller the building the higher the cubic factor for a given type of construction. Conversely, the greater the area the lower the relative cubic cost. This is because a smaller house has greater wall surface in proportion to the floor area.

To obtain the cubic contents of a building, the outside width and depth are multiplied to determine the number of square feet; this figure is then

multiplied by the height, measured from the basement floor to a point representing the average height of the roof. Enclosed heated porches and sun rooms are usually included at their full cubic contents. Open porches are generally calculated at one-half their cubic contents. In the case of buildings without basements, the measurements should be taken from the ground line, and in the case of large buildings having deep foundations, the height should be measured from a point below the basement floor equal to one-fifth of the depth of the foundation.

The cubic foot method of valuation is based on the assumption that if a building of a given type of construction, size, etc., has actually cost a certain sum of money, its actual cost per cubic foot may be applied to the cubic foot measurement of another building of like type, size, etc., and the result will be the value of that building. The theory is correct if we adhere strictly to the

## Building Costs in Cents per Cubic Foot.

| Classification of Building | Years 1920 | 1921 | 1922 | 1923 | 1924 | 1925 | 1926 | 1927 | 1928 | 1929 | 1930 | 1931 | 1932 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| RESIDENCES | | | | | | | | | | | | | |
| Brick | .65 | .45 | .40 | .49 | .50 | .49 | .49 | .48 | .48 | .49 | .50 | .39 | .34 |
| Brick Veneer and Stucco | .52 | .36 | .31 | .39 | .38 | .37 | .37 | .37 | .36 | .37 | .37 | .31 | .27 |
| Frame | .46 | .33 | .26 | .34 | .33 | .32 | .31 | .31 | .30 | .31 | .32 | .27 | .24 |
| Bungalow | .56 | .42 | .36 | .43 | .43 | .41 | .42 | .42 | .40 | .40 | .41 | .37 | .31 |
| GARAGES | | | | | | | | | | | | | |
| Fire-resistive | .33 | .24 | .22 | .26 | .26 | .27 | .26 | .26 | .26 | .26 | .27 | .22 | .18 |
| Mill construction | .22 | .16 | .15 | .17 | .18 | .18 | .17 | .17 | .17 | .17 | .17 | .14 | .12 |
| Brick (ordinary) | .19 | .14 | .13 | .15 | .16 | .15 | .14 | .14 | .14 | .15 | .15 | .12 | .10 |
| Frame | .14 | .11 | .09 | .11 | .12 | .11 | .10 | .10 | .10 | .11 | .11 | .09 | .08 |
| APARTMENTS | | | | | | | | | | | | | |
| Fire-resistive | .76 | .54 | .46 | .57 | .59 | .58 | .58 | .57 | .58 | .57 | .59 | .45 | .39 |
| Brick (ordinary) | .58 | .39 | .31 | .41 | .38 | .38 | .36 | .36 | .36 | .37 | .33 | .31 | .28 |
| Brick (veneer) | .56 | .40 | .33 | .42 | .40 | .39 | .38 | .38 | .38 | .38 | .39 | .33 | .29 |
| HOSPITALS | | | | | | | | | | | | | |
| Fire-resistive | .70 | .47 | .42 | .47 | .51 | .50 | .49 | .50 | .51 | .52 | .53 | .41 | .37 |
| Brick (ordinary) | .59 | .37 | .31 | .37 | .41 | .40 | .39 | .40 | .41 | .41 | .43 | .30 | .26 |
| HOTELS | | | | | | | | | | | | | |
| Fire-resistive | .73 | .54 | .46 | .56 | .59 | .59 | .58 | .58 | .57 | .58 | .60 | .48 | .42 |
| Brick (ordinary) | .63 | .45 | .35 | .47 | .47 | .43 | .41 | .41 | .42 | .42 | .42 | .35 | .31 |
| OFFICE BUILDINGS | | | | | | | | | | | | | |
| Fire-resistive | .67 | .50 | .42 | .53 | .54 | .53 | .52 | .52 | .51 | .52 | .54 | .44 | .38 |
| Brick (ordinary) | .47 | .33 | .30 | .35 | .36 | .36 | .35 | .35 | .36 | .35 | .37 | .30 | .27 |
| CHURCHES AND THEATRES | | | | | | | | | | | | | |
| Semi fire-resistive | .40 | .31 | .29 | .33 | .35 | .35 | .34 | .35 | .34 | .34 | .35 | .29 | .27 |
| Brick (ordinary) | .34 | .24 | .21 | .25 | .28 | .27 | .27 | .27 | .26 | .27 | .27 | .22 | .20 |
| STORES | | | | | | | | | | | | | |
| Fire-resistive | .50 | .35 | .33 | .38 | .40 | .40 | .39 | .39 | .38 | .39 | .40 | .32 | .30 |
| Brick (ordinary) | .36 | .25 | .23 | .27 | .28 | .27 | .27 | .27 | .28 | .27 | .28 | .22 | .19 |

NOTE: The indicated rates do not include equipment involved for maintenance of buildings, such as elevators, ventilating systems, power units, refrigerating apparatus, sprinkler systems, etc. Such major accommodations and maintenance equipment values are estimated separately.

principle on which it is based, *i.e.*, buildings of like type, quality of materials, finish, size, etc. When these conditions are apparent, the tables furnished will act as a general guide. When these conditions do not exist, adjustment must be made from the figures in the table to fit the particular building that is under consideration for valuation.

### Depreciation.

There is no defined rule or procedure to follow to determine the amount of depreciation for various types of buildings, due to variations in care and maintenance, age, obsolescence and other physical conditions. Tables showing structural depreciations of different types of buildings are plentiful, but they are generally averages of various estimates. The following estimates, although general in their nature, may be useful as a guide to be tempered with judgment when the depreciation is about normal. Depreciation deductions may be made when considered appropriate in conjunction with the cubic foot building cost estimates.

| Type of Building | Type of Roof | | | | |
|---|---|---|---|---|---|
| | Tin | Slate | Shingle | Gravel | Tile |
| Stone | 1.3% | 1% | 1.5% | 1.2% | 1% |
| Brick, hollow tile, concrete block | 1.4% | 1.1% | 1.5% | 1.3% | 1.1% |
| Concrete | 1.3% | 1.2% | 1.4% | 1.2% | 1.2% |
| Wood frame | 2.8% | 2.7% | 3% | 3% | 2.7% |

By the use of the foregoing tables, fire department officials or others wishing to interpret approximate building values for those classifications of properties mentioned may obtain reasonably close estimates. Such calculations must necessarily be modified by good judgment of the existing conditions of the property or local labor and material costs varying from the country-wide averages referred to in the tables.

### Example.

The following example will indicate how to estimate the approximate value of a two-story and basement, fire-resistive building, occupied as an apartment house. Physical condition good. No especially ornamental features on the interior or exterior. Depreciation considered normal.

Length—135 ft. Width—60 ft. Average height—38 ft.

Year erected—1922.

Classification—Fire-resistive, brick walls and slate roof.

Cubical contents—38 ft. x 135 ft. x 60 ft.=307,800 cubic feet.

From building costs in cents per cubic foot table, erection cost for this classification in 1932=$0.39 per cubic foot.

The cost of erection in 1932=307,800 x .39=$120,042.

Normal depreciation (see Depreciation Tables) for this classification. Use as a guide only. (1% per year.)

Total depreciation from 1922 to 1932=11%.

Depreciation of building is approximately $120,042 x 11%=$13,204.

Estimated present valuation=$120,042 — $13,204=$106,838.

# The Southern California Earthquake.

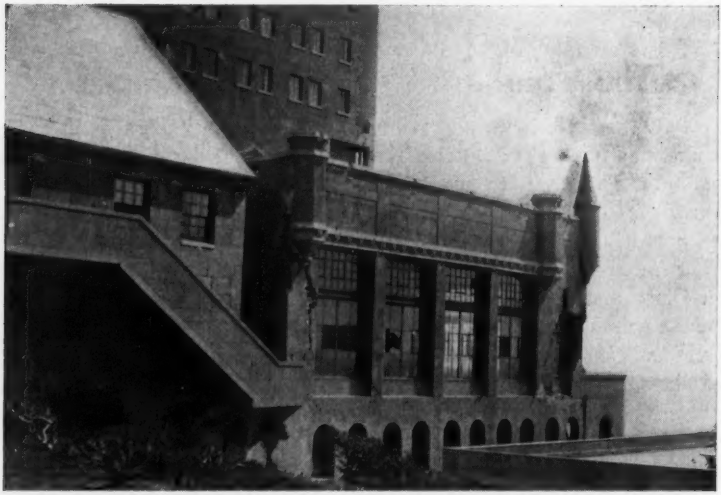
On March 10, 1933, at 5:45 P.M., Southern California was visited by the first and heaviest of a series of earth shocks, the duration of which was from seven to fifteen seconds, the lower limit being that observed farthest from the epicenter. The earthquake did considerable damage throughout an area approximately 25 by 35 miles, and was felt generally in the Counties of Los Angeles, Santa Barbara, Imperial, Orange, Riverside, San Bernardino, San Diego and Ventura. As near as has been determined at the present time the epicenter occurred approximately two miles west of Newport Beach. Direct and consequential human casualties in the affected area were 113 dead and about 2000 injured who were treated in hospitals. The incidental fire damage was moderate. With a few exceptions the fires following the earthquake were extinguished in their incipiency despite impairment of fire protection, and there was no threat of any general conflagration.

Various estimates of the loss occasioned by the earthquake have been released, ranging as high as $50,000,000. The damage was most extensive in the cities of Long Beach and Compton, although damage was suffered by most buildings in the business districts of San Pedro, Seal Beach, Huntington Beach, Laguna Beach, Santa Ana, Anahein, Fullerton, Buena Park, Norwalk, Downer, Huntington Park, Vernon and the southerly portion of Los Angeles. Three principal types of buildings were affected by this earthquake—fire-resistive structures having reinforced concrete or structural steel skeleton frames; ordinary joisted buildings with masonry bearing walls; and wood frame buildings.

### Fire-resistive Buildings.

Practically all of the fire-resistive buildings involved were in Los Angeles and in Long Beach. In Los Angeles buildings of this type suffered considerable damage, although there was little, if any, structural failure. The majority of buildings of this type which suffered damage had unit masonry filler walls, reinforced concrete floors, hollow tile or gypsum block partitions and were 150 feet high, the height limit in the City of Los Angeles. Damage to these structures consisted for the most part of cracking or spalling of the facing of exterior walls and the destruction of interior partitions. In many instances the marble facing of interior partitions will require resetting.

NOTE: The principal source of information used in the preparation of this article is an abstract by Mr. J. E. Shield, Structural Engineer, Board of Fire Underwriters of the Pacific (Member N.F.P.A.), from a complete report in course of preparation by that organization. Additional material has been incorporated from the following sources: Structural conditions, *Engineering News-Record;* fire alarm systems, Gamewell Co.; oil field experience, George F. Prussing (Member N.F.P.A.).



**A view of the west wall of the Pacific Coast Club at Long Beach, showing earthquake damage. This building had concrete floors and roof, with hollow tile panel exterior walls and hollow tile interior partitions.**

Practically none of the buildings suffering damage contained any bracing to resist lateral forces.

Similar damage in an intensified form occurred to fire-resistive buildings in Long Beach, where numerous instances of structural damage were evident. Due to the distortion of the building frames, the fracturing of exterior walls and interior partitions was very general. This indicates the virtual impossibility of getting any bond between the frame and the filler walls.

### Joisted Masonry Buildings.

Ordinary joisted construction with masonry bearing walls suffered most. In structures of this type the damage varied from broken plate glass fronts and cracked or fallen parapet walls to complete collapse. In commenting on this type of construction, an article by Mr. J. I. Ballard in *Engineering News-Record,* issue of March 23, 1933, states:

> The glaring weakness of brick-joisted construction was its lack of lateral supporting power and the lack of connection unity. In defense of the material it may be said that many buildings of this type were old; but on the other hand there were examples of new brick structures in bad state of collapse.
>
> An outstanding feature of destruction was the wholesale collapse of parapets or front fire walls of one-story brick buildings along business streets. These walls, often resting on steel lintels or containing a plane of weakness as the result of inserting a metal flashing at the roof line, proved to be particularly susceptible to earthquake destruction. In some cases the lateral support provided by the walls kept the ends from dropping out, while in other cases the shaking loose of the fire wall carried out the entire front.

*International.*

**With brick walls down and roof and floors intact, this Long Beach apartment building typifies the damage sustained by this type of construction.**

On some two or three-story structures the effect was the same. Often the top wall was dislodged and the second-story wall remained in place. Fallen brickwork separated into individual bricks in almost every case, indicating a poor grade of workmanship or of mortar.

While it is obvious that serious defects were prevalent in this type of construction it should not be concluded that all brick construction was unsatisfactory. Innumerable single-story brick buildings came through without apparent damage, and there were some outstanding examples of three and four-story brick-wall structures that showed only minor cracking. However, these serve to emphasize the condition of those that failed.

Masonry work of concrete blocks, as a rule, indicated comparatively more stable construction, and there are several examples of structures of this type that escaped without injury. Reasons for this may include use of Portland cement mortar, irregular size of units that provide some interlocking effect by random laying, and more modern architecture that produces simpler treatment of walls. The comparatively few small modern monolithic-concrete buildings were outstanding in their record of stability and freedom from injury.

School buildings throughout the district and particularly in Long Beach and Compton suffered severe damage. Most of these structures were of brick-wall and timber-floor construction. Quoting again from the *Engineering News-Record:*

The wholesale wrecking of these buildings was striking and was supplemented by the further shaking off of extensive architectural treatments over entrances, even though the building was not seriously damaged. In the few cases where a monolithic-concrete building was located on the same school grounds, the comparison was so marked as to cause public comment. Apparently two fundamental errors of the past have been the attempt to secure too much building for the money available and the sacrifice of sound construction for architectural effect.

*International.*

**School buildings, being mostly of masonry wall and timber-floor construction, suffered extensively. The photograph shows a typical collapsed school building.**

Wood frame dwellings on the whole suffered little damage other than the usual loss of chimneys, except where the foundation was defective. Many examples of shifting on or falling from foundations occurred in Long Beach and Compton.

Numerous cases of structural failures of gravity water tank towers were observed both in those tanks supported direct from the ground and those on top of buildings, and of both steel and reinforced concrete construction. In Long Beach the collapse of a low tank tower (approximately 10 feet above the building roof) dropped the tank completely through the reinforced concrete roof and partially through the floor below. This severely racked the two upper floors of the building.

### Fire Damage and Effect of Quake on Fire Protection.

Considering the potential hazard the loss by fire following the first shock was relatively small. In practically every instance fires starting were confined to the building of origin. The fact that prompt action was taken by those in charge of public utilities (gas and electricity) in shutting off these services was no doubt the reason that more fires did not occur.

The two most serious fires occurred in school buildings, the Polytechnic High School in Long Beach and the Huntington Park High School. Both of these buildings caught fire immediately following the earthquake and were completely gutted.

Fire protection was adversely affected in Long Beach, the largest of the more stricken communities, by small breaks in the water system, failure of the fire alarm system, partial failure of the telephone system, collapse of

*International.*

**A Long Beach fire station which partially collapsed as a result of the earthquake. Fire alarm headquarters was located in the central fire station, which was completely wrecked, causing the death of several firemen and putting the fire alarm system out of commission.**

some of the fire stations and consequent barricade of débris, accumulation of débris in the streets and some casualties in the personnel of the fire-fighting forces.

The Long Beach fire alarm headquarters was in the central fire station, which building was completely wrecked, causing the death of several firemen. Naturally the fire alarm system was rendered inoperative along with the telephone. This justifies again the recommendation that a fire alarm system should be in an isolated central office in a non-hazardous location. In areas subject to earthquake it should also be made as shock-proof as possible in its construction.

*Acme Photo.*

**The high school at Huntington Park, California, caught fire following the earthquake and was totally destroyed. This picture shows the fire in its early stages.**

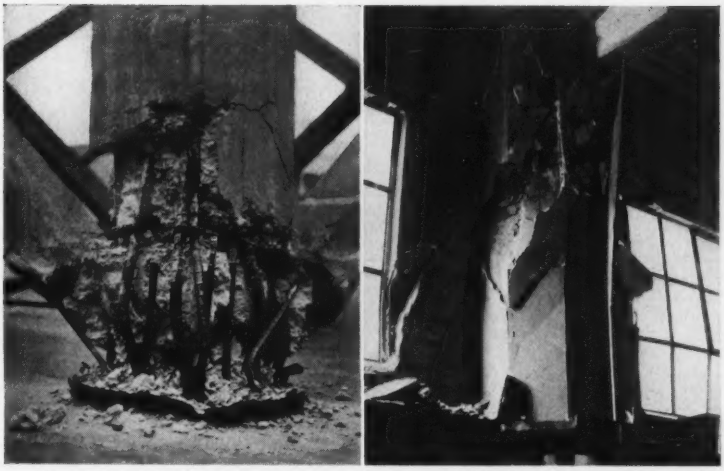
In other sections, including Los Angeles, the fire alarm system remained in operation in spite of the fact that telephones were out of commission all over the area. Thus there was still a reliable means of summoning the fire departments during and after the severe shocks, when numerous small fires broke out.

Of the sprinklered property in the affected area approximately 50 per cent suffered damage. Of the damaged systems 20 per cent had service impaired, but were capable of operation, while the remaining 30 per cent were completely out of service, some permanently and some for only a few days.

### Oil Properties.

The oil industry suffered a total loss of probably less than a million dollars. The largest single loss is represented by the damage to a very large boiler plant supplying process steam to a refinery. This was located out on the old delta of the Los Angeles River, a deep silt deposit in which the amplitude of the earth movement was magnified. No damage resulted to the steel and glass boiler house, but the large water tube boilers were shifted bodily several feet on their foundations. It speaks well for the design of the plant that there was no broken steam overhead piping, though water piping underground was shattered.

Signal Hill is the largest producing field in the area. The community of Signal Hill has a small water supply located close to the base of the Hill from which water is pumped continuously to a standpipe at the top of the Hill. This tank collapsed, hence the only available supply was that furnished by the pump which was electrically driven. However, a few weeks previous



**Two views showing damage to columns. (Left) Damage to one of the columns of a concrete tower on a building in Los Angeles. (Right) Interior view of Marti Building, Long Beach, showing column fracture. This building was of reinforced concrete flat slab construction. The failure occurred through a construction joint.**

to the earthquake a wind storm had dropped a derrick across the power line supplying this pump, causing a fire that exhausted the gravity supply of water.

The fire protection engineers of the companies operating in this area thought it best to shut down the field as well as the refineries and gasoline plants located close by. The Governor was asked to issue such an order, but it was successfully opposed by the local fire chief. Local pride therefore prevailed against expert opinion and while the major operators shut down their properties the fire hazard was merely reduced, not eliminated. Fortunately there was but one fire, involving two derricks and three small tanks.

Earthquake damage consisted largely of broken lines and fittings, resulting in a moderate loss of oil, much of which was recaptured and pumped into other tanks. Moderate damage was done in the cracking units of one plant and to the brick buildings of another. There were no other fires affecting oil breaks. A fuel gas line broke and ignited out in an open field near Long Beach, but no particular damage was done.

### Loss of Life.

The loss of 113 lives may be almost entirely attributed to falling walls, cornices, and débris from architectural treatments. It was particularly fortunate that the shock did not occur about three hours earlier in the day when the schools would have been in session. The collapsed condition of a score of school buildings indicates that, in such a case, the loss of life would have

**Wood frame dwellings on the whole suffered but little damage other than the loss of chimneys, but many examples of shifting on or falling from foundations occurred. This dwelling was located in Compton.**

been appalling, probably reaching well into the thousands. As it was, the first shock, occurring when streets were full and stores and buildings were emptying, resulted in greater loss of life and injury than if it had come later in the evening.

## Conclusions.

The lessons to be learned from the structural damage to buildings of various types are not new, but they cannot be too strongly emphasized. The faults cannot be represented as being those exclusively of poor material or workmanship, but rather of disregard of proper construction features essential for earthquake resistance. Buildings must be adequately braced and the elements of a structure must be securely connected to form a unit if satisfying behavior in earthquake shocks is to be expected. Correction can only be made on those buildings yet to be built and then only when those concerned realize the hazard involved and the need for earthquake-proof design, particularly in public buildings.

Among the vital points essential for earthquake-resistant construction again brought out by this disaster are:

1. The need for rigidity in the structure of large buildings to minimize deflections. With so-called flexible designs this applies to the rigid portion above the flexible zone.

2. The need for careful cleaning of construction joints in concrete walls and structures. Joints should be keyed, roughened, cleaned and grouted before resuming pouring.

3. Joisted masonry buildings should have reinforced tie bands at each floor and roof level and at the top of parapet walls. Such bands help to minimize damage and prevent collapse.

4. All ornamental features should be properly anchored. Lack of such anchorage was indicated by parapet copings sliding off parapets.

5. Failure of parapets resting on steel lintel girders in store fronts shows the necessity of bolting or riveting steel anchors to beam, and extending into parapet.

6. Evidence shows that strong mortar alone will not produce safe brick bearing walled buildings.

7. Towers should never be erected over entrances to joisted masonry buildings unless extreme precautions are taken in their design and construction.

8. Failure of tank towers shows the inadequacy and danger of skeleton concrete framing where sole resistance is by bending in the columns. Concrete tank towers should always have monolithic concrete walls.

**There were numerous instances of structural failures in gravity water tank towers of both steel and reinforced concrete construction. The ruins of this steel tank and tower at Southgate is an example of a typical collapse.**

# Venting Dust Explosions.

By Hylton R. Brown and Richard L. Hanson.*

***The Committee on Dust Explosion Hazards of the National Fire Protection Association, under the leadership of Dr. David J. Price (member N.F.P.A.), Principal Engineer in Charge of the Chemical Engineering Division, Bureau of Chemistry and Soils, United States Department of Agriculture, is engaged in the formulation of safety codes for control and prevention of dust explosions in industrial plants subject to this hazard. This article on venting dust explosions in the primary stages relates directly to the review of dust explosions published in the January, 1931 Quarterly. In the safety codes already prepared the Committee has recommended venting as an effective method for controlling the extent of dust explosions. Through these codes prepared by the Committee in co-operation with the industries concerned, the results of the technical research of the U. S. Department of Agriculture have been translated into actual practice. As the result of the Committee's activities in co-operation with the Department of Agriculture, the losses from dust explosions in industrial plants since the origin of the work in 1922 have been materially decreased.***

The Chemical Engineering Division of the Bureau of Chemistry and Soils in the United States Department of Agriculture has given special attention to the development of safety measures for dust explosion prevention in grain-handling and other dusty industries.[1] Through its publications the Bureau has advised the use of light construction and of hinged panels or sash because investigations of explosions showed the desirability of quick venting at low pressures.[2] Built up pressures produce undue spread of flame and secondary explosions, which are responsible for the major part of the life loss and damage to structure and equipment.

*Mr. Hylton R. Brown, Secretary of the N.F.P.A. Committee on Dust Explosion Hazards, is Engineer in the Chemical Engineering Division, Bureau of Chemistry and Soils, United States Department of Agriculture. Mr. Richard L. Hanson is Assistant Engineer in the Division. The publication of this report in the N.F.P.A. QUARTERLY has been authorized by the Department of Agriculture.

1. Dust Explosions. Price and Brown, N.F.P.A., Boston, Mass., 1922.
2. A Review of Some Recent Dust Explosions. David J. Price and Hylton R. Brown, N.F.P.A. QUARTERLY, January, 1931.

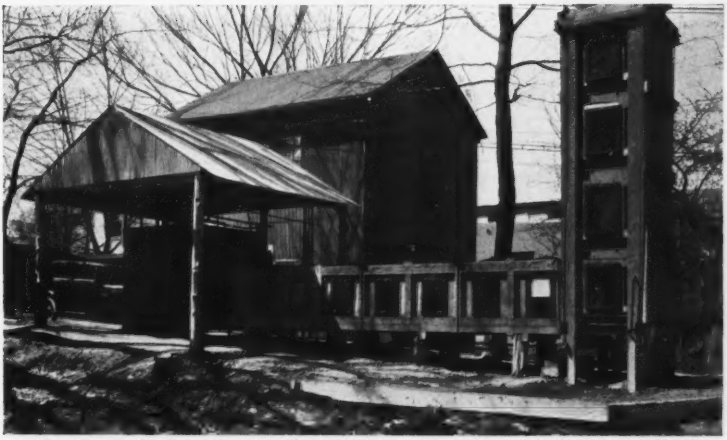


**Fig. 1. U. S. Department of Agriculture Experimental Station, Arlington, Virginia, showing special equipment erected for the purpose of studying the venting of dust explosions.**

Since 1922 this work of the Bureau has been made available to industries through safety codes prepared by the Dust Explosion Hazards Committee of the National Fire Protection Association under the leadership of the Chemical Engineering Division.[3] The recommendations for venting at lower pressures have resulted in the development of several types of swinging vents. Some are held shut by weight or inertia alone. Others use a light friction catch. A friction device also is used to resist the opening of the vent throughout its swing and to hold it open. Still other vents, particularly sash, may be pushed from the frame in such manner that the explosion may pass out on all sides. This opening is limited by folding or sliding brackets at four points. Another type of outlet is formed by the application of louvers.

It is not the purpose of this article to compare the merits of the various types of swinging vents, but rather to show their desirability, as compared with the use of fixed glass. All of the vents have particular advantages, depending upon the type of structure, the cost, and the frequency and severity of the explosions to be anticipated.

In order to obtain accurate data on the venting area required for various explosive dusts with the different types of venting, special apparatus and equipment have been installed at the Arlington, Virginia, Experimental Station of the U. S. Department of Agriculture. This experimental structure, in which the venting of dust explosions can be studied, consists of a room, a gallery, and a tower erected and connected as shown in the accompanying photograph, Fig. 1.

3. Safety Codes for the Prevention of Dust Explosions. U. S. Dept. of Labor Bulletin No. 562, Dec., 1931.

**Fig. 2. Near view of dust explosion experimental structure, showing types and arrangement of vents.**

The room, 4 x 5 x 5 feet, has a volume of 100 cubic feet. The gallery, 2½ x 2½ x 20 feet, has a volume of 125 cubic feet. The tower, 3 x 3 x 12 feet, has a volume of 108 cubic feet. Total volume of the structure is 333 cubic feet. Vents on the room consist of hinged metal doors and pivoted sash. The metal doors range in size from 0.1 sq. ft. to 1.55 sq. ft., and the sash contain approximately 7 sq. ft. of glass.

The gallery has eight roof vents, each 1 sq. ft. in area, covered by hinged doors. There are also eight fixed glass windows, with an area of 1.3 sq. ft. each. The opening into the tower, which is the full size of the gallery, may be closed when the gallery is used as a unit.

The tower contains one swinging panel about 7 sq. ft. in area, three hinged doors, each 1.55 sq. ft. in area, an adjustable vent on top, ranging from 0.1 sq. ft. to 2.75 sq. ft., and four fixed glass windows, with an area of 1.7 sq. ft. each. Many of the vents on the structure are shown in Fig. 2.

The fixed glass windows in the structure provide a factor of safety by breaking when the venting area is not sufficient to prevent the development of excessive pressures.

Dust may be sprayed into suspension in the air within the structure from hemispherical cups by jets of compressed air. There are eight of these 6-inch cups in each of the three sections of the structure, and the dust clouds may be prepared independently or simultaneously. The cups in the room are placed at two different levels as shown in Fig. 3. Fig. 4 illustrates the arrangement of the cups in the gallery. In the tower the cups are arranged in pairs at four different levels. Ignition is produced by a glowing electric heater coil. The position of the coil when used in the room may be seen in Fig. 3. Pressures produced by the explosions are recorded by rubber diaphragm manometers which may be installed at a number of points on

**Fig. 3. (Left) Interior of dust room, showing filled cups from which dust is distributed by jets of compressed air. Ignition is produced by a glowing electric heater coil in the center of the room. Fig. 4. (Right) Interior of gallery, showing arrangement of dust cups.**

the structure. These manometers are calibrated to record pressures up to 800 pounds per sq. ft.

The method of making the tests is as follows: The charge of dust to be used is placed in the cups, the vents to be used are unlatched or set to operate, the manometers are placed and the ignition coil is heated to its approximately constant temperature. The compressed air line leading to the jets above the dust cups is then opened, and as the dust cloud forms around the coil, the explosion occurs. Fig. 5 shows a typical explosion being vented without breaking glass.

### Characteristics of Different Dusts Tested.

Early in this work it was found that not only did the various dusts behave differently when ignited in suspension, but that the clouds were best prepared in different manners. Grain dust, being low in apparent density, was easily dispersed. Cork dust is even lighter and thus more easily handled. On the other hand, starch and sugar of high density could be better dispersed by using only the lower four cups in the room and applying higher jet pressures. Also some were quick to ignite, and others, such as soap powder, were very slow to "take hold."

With a very light dust such as a fine granular cork the density was so low and the dust flowed so easily that a deposit of such dust on the floor and on ledges or shelves along the gallery could be easily thrown into sus-

**Fig. 5. A typical dust explosion being vented without breaking glass in the fixed glass windows of the tower and gallery.**

pension and ignited by an explosion in the room partly vented into this prepared gallery.

To maintain uniformity in the tests it was often found necessary to dry dusts to less than 8% moisture—particularly those hygroscopic in nature, the explosibility of which was reduced in damp or cool storage. Certain dusts tended to agglomerate, particularly when very fine, and offered some trouble in obtaining good dispersions. The cups had to be carefully loaded, in some cases level and in others evenly rounded or heaped.

The size of the charge of dust was such as could be depended upon to produce a heavy concentration. Since the aim was to protect against the maximum hazard, only the more severe explosions were studied. Also the location of ignition that would produce the maximum explosion was selected. When once located for the various units, it was found to hold well for most dusts and only changed to suit a few specific cases or dusts.

Where fine dust was used, the explosions tended to be sharp and of short duration. When grain dust, which in addition to fines contains a considerable quantity of chaff (all passed through a 30-mesh screen, 85% through 40 mesh, and 31% through 100 mesh) was exploded, the shot was positive, but lower in pressure, of longer duration, and with more flame. This is due to the fact that while the fine portion furnishes the ignition, the chaff feeds the flame to prolong the flash and help carry the fire to remote portions of plant or structure.

### Determining the Breaking Strength of Glass.

Believing that too much dependence was being placed on fixed glass as a means of venting explosions in industrial plants, the first series of tests was arranged to determine the actual breaking strength of glass. Standard factory sizes, 12″ x 18″ and 14″ x 20″, of double strength A-quality glass were set in steel sash and wooden frames. In a number of cases this glass withstood pressures of more than 300 pounds per square foot, and in several cases pressures of 400 pounds per square foot or more were recorded without breaking the glass. Assuming 300 pounds per square foot as the pressure such glass could be expected to withstand, the total pressure exerted on a 4 x 8 foot sash would be almost five tons. Such pressures are capable of causing serious damage to both structure and equipment. This fact explains why in a number of factory explosions, the entire steel sash has been blown out of its anchorage in the building wall and indicates the necessity of providing some form of explosion vents capable of operating at much lower pressures. Assuming, therefore, that the breaking of glass indicated the pressure at which structural damage would occur, a series of tests was planned to determine:

1. Venting area per unit of volume necessary to prevent structural damage.
2. Effect of location and distribution of vents.
3. Effect of differences in size and type of ignition.
4. Reduction of pressure due to increase in venting area.
5. Effect of outside glazing.
6. Effect of scoring glass to reduce the breaking strength.

In these tests steel doors of different sizes, operating only against their own inertia, were used as vents.

### Venting Area Necessary to Prevent Structural Damage.

It was necessary to perform a rather lengthy series of tests in order to determine the venting area which would be required in a room or building in order to prevent the breaking of fixed glass, or the building up of pressures exceeding 300 pounds per square foot, which as previously stated was arbitrarily taken to be the point at which structural damage would occur. Starting with the room alone, which had a volume of 100 cu. ft., fifty-eight explosions of starch dust were produced, with different arrangements of the vent openings. Although it was found that a number of factors, which will be treated under separate headings later, had a bearing on the results obtained, the general conclusion reached was that to provide satisfactory venting for an explosion of starch dust in a cube-shaped or approximately square room of small size, 3 sq. ft. of vent for each 100 cu. ft. of volume would be necessary. This conclusion is based on the fact that, although there were two explosions in which pressures of 210 pounds and 245 pounds were recorded

when the vent openings had a total area of 4.65 square feet per 100 cu. ft., a number of explosions were vented through smaller openings at pressures below 300 pounds per square foot.

With grain dust slightly different results were obtained. Sixty-six explosions were produced, with different arrangements of the vent openings. The amount of vent opening in the room was gradually reduced to the point at which breakage of glass occurred. Based on the results obtained and drawing conclusions from the fact that in a number of cases pressures were as high as 250 pounds per square foot when the vent openings had an area of 1.55 square feet (pressures exceeding 300 pounds were recorded with openings of 1.1 square feet) it is recommended that for satisfactory venting of grain dust explosions in cube-shaped or approximately square rooms of small size, 1.25 sq. ft. of vent be provided for each 100 cu. ft. of volume.

Although no extensive series of tests were made with other dusts, there were enough to indicate the pressures produced in comparison with starch and grain dust. The results obtained with sugar, wood flour, sulphur, cork, powdered milk, soap powder, wood charcoal, and similar products indicated that the venting necessary for these dusts ranges between the requirements for starch and grain dust.

When the tests were extended to include the gallery and tower, the results indicated very definitely that the shape of the room is an important factor to consider in determining the amount and the location of the vents required to release explosion pressures without structural damage. It was found, for instance, that an explosion propagating through the gallery, which is 2½ x 2½ x 20 feet, produced a gun barrel effect with rapidly increasing pressures. Glass along the side of the gallery would be broken before these pressures could be released through openings at the end of the gallery of the size recommended for cube-shaped rooms.

A few shots in the tower indicated that the same conditions met in long narrow galleries also existed in deep, small-diameter bins, and venting at the top only, in the ratio recommended for rooms, would not be satisfactory.

These preliminary tests showed the need for further tests to determine the effect of location or distribution of vents.

### Effect of Location and Distribution of Vents.

In the room tests with the ignition at the center and the vents centrally located in each panel, very little could be done in the way of studying the effect of location and distribution of vents. There was an indication, however, that one or two larger vents were more effective than several smaller ones totaling the same vent area — this probably being due to the resistance offered to flow through small openings.

The effect of location and distribution of vents was most successfully studied in the gallery tests. In these tests the gallery was used as a closed

unit, as shown in Fig. 6. The ignition in each case was located as shown in the center of the gallery section below vents G and H. The manometer was located as shown. Grain dust was used throughout.

TABLE I.

Gallery Tests (Grain Dust).

| Vents Used | No. of Tests | Total Vent Area | Glass Broken | Average Pressure | Vent per 100 cu. ft. |
|---|---|---|---|---|---|
| NP ..... | 11 | 2.0 sq. ft. | 7 | 356 | 1.6 |
| ½G ..... | 9 | 0.5 sq. ft. | None | 214 | 0.4 |
| NP & ½M..... | 3 | 2.5 sq. ft. | None | 141 | 2.0 |
| HKMP (part opening)... | 2 | 1.0 sq. ft. | None | 312 | 0.8 |
| HKMP (part opening)... | 3 | 1.7 sq. ft. | None | 153 | 1.35 |
| All vents (small opening).. | 2 | 1.5 sq. ft. | None | 172 | 1.2 |

From this table it may be seen how vents N and P at the opposite end from the ignition are inadequate protection, although they more than conform to the total vent required for a cubical structure. Conversely, ½G provided all the vent necessary to prevent the breakage of glass. Here the vent was much less than that required in a cubical structure of similar volume. This vent, being so close to the ignition source, dissipated the pressure rapidly and permitted a very slow propagation toward the closed end of the gallery. This type of protection can not be advised because the exact point of ignition in an industrial plant explosion is not predetermined, but it does show how much more effective the vent becomes when it is located close to the ignition source.

These findings agree very closely with those of Greenwald and Wheeler[4] in their work at the British Experimental Station at Eskmeals, England, in tests with bituminous coal dust in a cylindrical steel gallery 7½ feet in diameter and 750 feet long. The pertinent conclusions of these tests were: (1) Where the openings are near the origin of the explosion, they are more effective in checking the propagation than corresponding openings located along the path of the explosion where the propagation is being developed; (2) "The influence of openings along the path of an explosion is mainly one of release of pressure, so that when the openings are ahead of the flame its velocity is increased and when behind its velocity is decreased." This matter of effect of location of vent on flame speed was readily observed in the gallery tests at Arlington, the size of the gallery, however, being too small to consider measuring this phenomenon. It is interesting to note that the Eskmeals tests and those at Arlington, while on a vastly different scale and with different materials, produced results or permitted observations which were analogous.

When the venting was distributed along the gallery and either four vents or all eight vents were used, the amount of safe opening corresponded

4. Paper No. 14, Safety in Mines Research Board, 1925, H. M. Stationery Office, London.

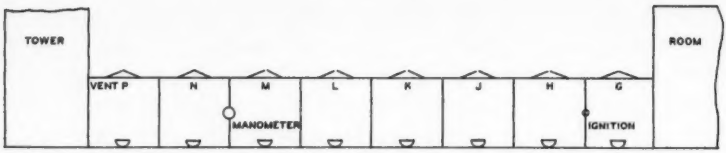



**Fig. 6. Diagram of gallery where used as a closed unit.**

very closely to that for the room tests. This is shown in the lower part of Table I. As the venting of the gallery at the end opposite the ignition was extended to include NP and ½M, sufficient protection was furnished to lower the pressures and prevent glass damage. It may be seen that this is not entirely due to the increased vent, but also to the increased distribution. (See Fig. 6.)

This advantage of using distributed vents is still further emphasized in a comparison of several explosions of starch dust. With 3.25 sq. ft. of vent evenly distributed throughout the length of the gallery an explosion of starch dust ignited by a flash from the room produced a pressure of 155 pounds per sq. ft. With 4 sq. ft. of vent distributed in the half of the gallery remote from the source of ignition an average pressure of 470 pounds per sq. ft. was recorded. When all vents along the gallery were closed and the end left entirely open to provide 6.25 sq. ft. of vent, large amounts of glass were broken and pressures exceeding the manometer scale, but estimated to be as high as 1500 pounds per sq. ft., were produced.

If any elongated structure is to be protected against dust explosions, whether it be tower, gallery, or L-shaped building, the building should be sectioned or zoned into cubical units. The vents may then be applied for each of these units at the limits of the unit itself. That is, vents should be in the amount recommended for the particular dust, and for the volume of the cubical unit and should be located in the roof or outer wall enclosing the cubical unit or zone being protected. From this it may be seen that when a dust hazard is located in the center of a building between floors where the distance to an outer wall exceeds the height of the ceiling, venting is difficult and complicated.

### Effect of Differences in Size and Type of Ignition.

Undoubtedly the size and type of ignition are responsible for many of the differences noted in dust explosion tests. Trostel and Frevert in their study of the lower limits of concentration for explosion of dusts in air[5] called attention to this fact and listed their results obtained with three types of ignition, namely, a glower at 1200°C., an arc at 33 volts 5 amperes, and an induc-

5. "The Lower Limits of Concentration for Explosion of Dusts in Air," by L. J. Trostel and H. W. Frevert, Chemical & Metallurgical Engineering, Vol. 30, No. 4, January 28, 1924.

tion coil spark produced by a flow of 3 amperes at 6.5 volts in the primary winding.

No attempt will be made in this article to draw a fine distinction between different types of ignition. In fact, the glower, an electric heater coil, was used in all tests for the primary ignition, and preliminary tests indicated that changing the position of the ignition coil in the room did not have any appreciable effect, except perhaps to change slightly the time interval as it was raised or lowered when light or heavy dusts were being tested.

A marked difference was noticeable, however, between what may be termed primary and secondary ignitions. For instance, explosions in the gallery and tower occurred much more quickly, and the pressures rose much more rapidly, when dust clouds in those parts of the structure were ignited by a flash from a primary explosion in the adjoining room than when the coil alone was used as the source of ignition. This difference is believed to be due to the fact that the flash from the primary ignition in the room, when partly vented through a small opening into the gallery, took the form of a flame eight feet or more in length. The flame ignited the dust cloud at about the same time throughout its length, while the coil in the gallery itself produced an ignition at only one point, and it was necessary for this ignition at the coil to propagate through the dust cloud, relatively a much slower process which produced a slower pressure rise.

The results obtained in this series of tests were as follows:

Explosions of grain dust ignited by a coil in the gallery produced an average pressure of about 180 pounds per square foot, when 3 sq. ft. of vent was provided. Under the same conditions, except that the ignition was produced by a flash from a primary explosion in the adjoining room, the average pressure was about 280 pounds, and in one case glass was broken. With grain dust ignited by the coil in the gallery a pressure of 235 pounds per square foot was recorded, with 2.4 sq. ft. of vent. With the same vents, when the dust cloud was ignited by a flash from the room, the pressures averaged more than 400 pounds, and in one case glass was broken.

When the vent in the gallery was reduced to 2.25 sq. ft., an explosion of grain dust ignited by a coil in the gallery produced a pressure of 400 pounds per sq. ft. With the same amount of vent and a similar dust cloud ignited by a flash from an explosion in the room, the pressure was 475 pounds, and two windows were broken.

Starch produced even more definite results, showing the difference between small and large ignition sources.

With 4 sq. ft. of vent, an explosion of starch dust ignited by a coil in the gallery produced a pressure of 270 pounds per sq. ft. With the same amount of vent and similar dust clouds ignited by a flash from an explosion in the room, an average pressure of about 470 pounds was recorded.

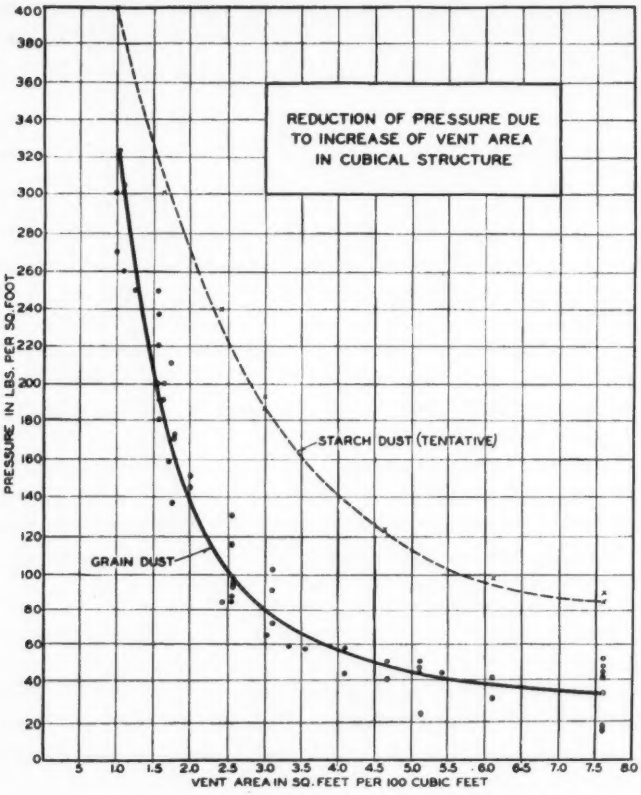



Figure 7.

When the venting area was reduced to 3.5 sq. ft., a pressure of 275 pounds was produced by an explosion of starch dust ignited by a coil in the gallery. With the conditions unchanged, except that a flash from an explosion in the room was used to ignite the dust cloud in the gallery, the pressure was 710 pounds.

With another reduction in the venting area to 3 sq. ft. an ignition of starch dust by a coil in the gallery produced 400 pounds pressure per sq. ft. The pressure recorded when a flash from an explosion in the room ignited the starch dust in the gallery, with the same amount of vent, was 700 pounds, and 2 panes of glass were broken.

These figures indicate clearly the added difficulty encountered in trying to vent a secondary explosion, and emphasize the advantage of providing

sufficient openings at all points in the structure to properly vent any primary explosion at the origin. By such means the secondary explosion may be wholly prevented.

### Reduction of Pressure by Increase in Venting Area.

The venting area per unit of volume previously recommended in this article is believed to be the minimum that should be used to provide protection against structural damage. Where additional protection is desired or necessary to prevent damage to equipment, extra vents should of course be provided. In fact any additional venting that can be provided will pay good dividends should an explosion occur, because as shown in a study of the tests, the explosion pressures dropped rapidly as the venting area was increased beyond the amount recommended. To show this reduction the pressures recorded with different vent openings have been plotted and curves drawn, as shown in Fig. 7. The points plotted for grain dust indicate very definitely the trend of the curve, showing the reduction in pressure which may be expected through an increase in the venting area. Believing that the curve for starch dust will follow closely the one for grain dust, it has been drawn accordingly through a smaller number of points representing typical starch shots.

Here again the data given are for cube-shaped units or small square rooms, and pending the securing of additional test data their application to long narrow rooms and galleries or high towers and bins can be based only on data from a few shots in the gallery and tower referred to under the heading, "Effect of location or distribution of vent." These tests indicate that the provision of vents in approximately the same ratio of area to volume as used in the room will be satisfactory, provided the venting area is distributed in such a way that each cubical unit of the structure has its share of vent. It is presumed that the increasing of this evenly distributed venting area will result in correspondingly reduced pressures, as was the case in the room.

### Effect of Outside Glazing.

During the making of tests to determine methods of venting or otherwise reducing the pressures that would be built up in a room or building where dependence had been placed on fixed glass for venting, it was suggested that outside glazing might permit the glass to be blown out of the frames at a pressure below that required for breaking. Accordingly the steel sash was reversed, and a series of tests arranged to determine the pressure at which glass would be blown out when placed in the frames from the outside with clips only, with plastic putty, and with commercial putty.

The first tests were made with clips only. Ten clips were used on 13″ x 19″ panes, and the glass was subjected to gradually increasing pressures produced by explosions of grain dust. The pressures were increased

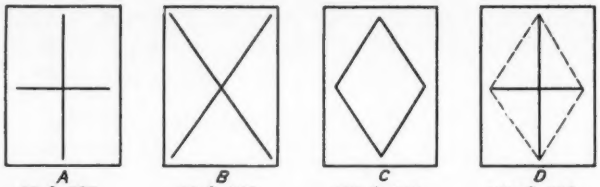



**Fig. 8. Four designs of scored glass tested and the pressures at which breakage occurred. Solid lines indicate cuts on outside surface; dotted lines on inside surface.**

by closing vents on other sides of the room as each successive explosion was produced. Undoubtedly the type of clip used, the manner in which they were used, and the type of explosion producing the pressure had an important bearing on the results obtained. These tests with clips were to determine their relative resistance rather than to determine their practicability. The average pressure at which glass was blown out when clips alone were used was about 50 pounds per sq. ft.

Plastic putty of a standard type with four auxiliary clips was similarly tested. This glaze required but 100 pounds per square foot to blow out the glass.

In like manner, commercial putty (whiting and linseed oil) with four clips per pane was tested after a few days aging. This required about 200 pounds per square foot to blow out the glass, or double that for plastic putty. Considerable added resistance is anticipated when glazing with commercial putty is tested from six months to a year after installation.

These results indicate that outside glazing with plastic putty has certain advantages worth considering in providing venting area for the release of explosion pressures. Outside glazing, however, particularly on high structures, probably would be more difficult and more expensive, and replacement of broken panes would be more hazardous.

### Effect of Scoring Glass to Reduce the Breaking Strength.

Another method suggested for reducing the pressure at which fixed glass would break and thus provide additional venting for an explosion before destructive pressures were reached was to score or partly cut the pane in such a way that comparatively low pressures would fracture the glass. From the results of the few tests made it was concluded that this method had some merit. Undoubtedly the depth and the design of the cut will affect to some extent the breaking strength of scored glass. It is believed, however, that such cuts will permit glass to be blown out at from one-half to one-third the pressure normally required to break it. Figure 8 shows four of the designs tested and the pressures at which breakage occurred.

Perhaps some other design of cutting will be developed that will allow the glass to fracture more readily under pressure from within. The few cases reported are given to indicate the possible value of the practice suggested, and it is believed that the simple designs A and B will be found satisfactory where such protection is desired.

It is understood that the scoring of glass is not recommended as a substitute for movable vents, but rather as additional protection where large areas of fixed glass are used in addition to the recommended amount of vent. Information is not available concerning the possibility of fractures occurring in scored glass due to extreme or sudden changes in temperature or to building vibration, but no breakage from this cause occurred during the tests.

## Summary.

The series of dust explosion venting studies originally planned have not been completed and only two dusts have been used to any extent, but it is felt that the results obtained and reported in this article are sufficiently definite to indicate that:

1. It is possible to vent dust explosions without structural damage.
2. Fixed glass offers too much resistance to permit dependence upon it alone for the release of explosion pressures without structural damage.
3. Many types of venting equipment, hinged doors, windows, and panels may be satisfactorily used to release explosion pressures provided sufficient venting area is provided.
4. Vents near the source of ignition are more effective than those located some distance away.
5. The venting area required varies for different dusts.
6. Secondary explosions are more difficult to vent than primary explosions.
7. A definite reduction in pressure results as the venting area is increased.
8. Pressures may be released by lowering the resistance of fixed glass by means of outside glazing or by scoring.

## Importance of Continued Experimental Work.

As indicated above, many of the studies have not been completed, and additional experimental work will be necessary to determine the venting area required to release the pressures produced in explosions of dusts other than those tested. A study of flame travel during dust explosions in different shaped rooms and a series of tests to determine explosion pressures in deep bins or vaults also will be desirable. The heavy losses of life and property already caused by dust explosions in different lines of industry are an incentive to carry on work which will aid in reducing or eliminating this hazard.

# Range Oil Burners.

The past two or three years have witnessed a rapid increase in the use of small oil burners designed for use in domestic stoves and ranges primarily intended for the use of solid fuels. This growth has been particularly evident in New England, where it is estimated that approximately 350,000 are now in use.

Range oil burners have been adapted to a variety of uses. For the most part they have been installed in cooking ranges and so-called "parlor" stoves originally intended for the use of coal in the lower class residential sections of the smaller cities and towns and in rural districts. As a result, however, of recent sales campaigns the use of these burners is being extended to the larger cities and many installations have been made in city dwellings and tenements. Range oil burners are also found in summer camps, detached garages, and in small mercantile establishments and shops.

The use of this type of burner in warm-air furnaces or steam or hot water boilers presents a marked increase in fire hazards in the opinion of the N.F.P.A. Flammable Liquids Committee and this committee has issued a warning in connection with such installations. Oil burners for installation in house heating furnaces or boilers must be of a type specifically approved for this use and no range burner should be so used unless particularly designed for this use and so approved.

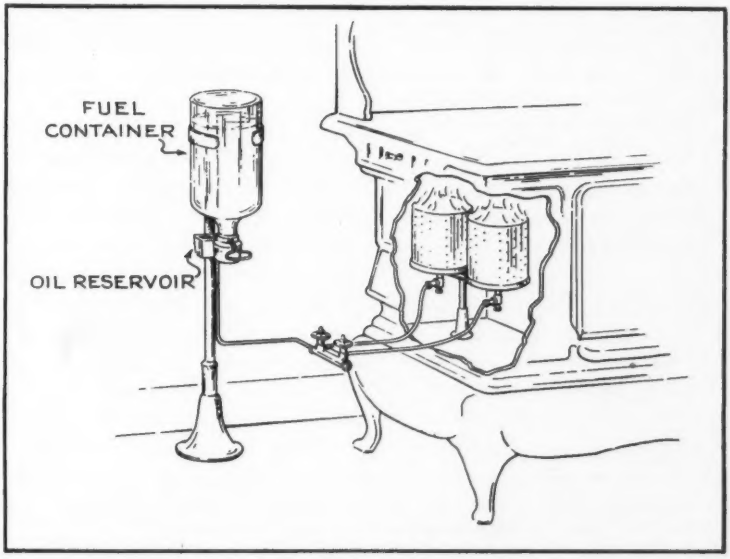
The simplicity of the burner, its low cost and the ease with which it may be installed have helped to make it a "best seller." The complete unit consists of the burner, a fuel container and stand, and the essential piping and valves to connect the two. The fuel employed is kerosene or so-called "range oil" of 38 to 40 degrees Baumé Test and having a flash point of not less than 100 degrees Fahrenheit.

The burner itself consists of two central vaporizing chambers each surrounded by a series of perforated metal rings or cylinders in which the vapor is burned. The fuel container consists of a glass bottle or metal tank of from one to three gallons capacity supported on a metal stand in such a way as to maintain a definite oil level in a small chamber or reservoir. Fuel is fed by gravity from the fuel reservoir through manually operated valves to the vaporizing chambers of the burner. The height and adjustment of the reservoir on the stand in relation to the height of the burner determine the depth of oil in the burner. This adjustment is an important factor in preventing flooding and overflowing.

## Fire Record of Range Oil Burners.

The files of the Department of Fire Record of the National Fire Protection Association contain reports of 190 fires involving the use of range oil burners. For the most part these fires have occurred during the years 1931 and 1932. Practically all of them have taken place in New England. This record has been made possible through the coöperation of the fire department officials of cities and towns who have made available their fire record experience for the compilation of these data. Other reports have been taken from newspaper accounts which have been verified by N.F.P.A. members or local fire chiefs.

Five potential fire hazards are inherent with range oil burners and result from faulty installation, improper adjustment and operation, defective




**Typical Range Oil Burner Installation.**

burners, careless handling of fuel and improper storage of fuel in dwellings. To what extent these conditions have been responsible for actual fires will be shown by the statistical data that follow, and the comments that have been extracted from letters received from fire department officials.

A large number of fires here recorded have presumably been due to the installation or subsequent adjustment of burners by inexperienced workmen or home owners. Where burners of the proper type have been selected and properly installed by experienced mechanics, operating difficulties have been

few and fires seldom reported. A vital feature is the proper adjustment of the oil reservoir, many fires due to overflowing or flooding of burners being chargeable in whole or in part to placing the oil reservoir level too high in relation to the burner.

**Causes of Range Oil Burner Fires.**

| | Number of Fires |
|---|---|
| Overflowing or Flooding of Burners | 129 |
| Improper adjustment or installation | 67 |
| Flooding, no cause given | 39 |
| Faulty installation or carbonization | 11 |
| Leaking burner, cause unknown | 10 |
| Carbonization | 2 |
| Other Fires Involving Burners | 20 |
| Defective burner | 11 |
| Flare-back due to faulty adjustment | 2 |
| Explosion, cause unknown | 3 |
| Damper improperly adjusted | 1 |
| Flare-up due to improper fuel | 1 |
| Improperly adjusted burner overheated flue igniting partition | 1 |
| Water boiled over on burner | 1 |
| Fires Involving Fuel Supply | 16 |
| Glass bottle broken by careless handling | 7 |
| Glass bottle broken by fire in room | 3 |
| Glass bottle broken by heat from burner | 1 |
| Glass bottle broken by children | 1 |
| Metal container burst by fire in room | 1 |
| Children tampering with valves | 1 |
| Oil spilled and ignited | 1 |
| Leak in oil piping | 1 |
| Storage of Fuel | 9 |
| Oil leaking from drum ignited | 5 |
| Tank overflowed, oil ignited from heater | 1 |
| Oil in glass bottle on piazza ignited | 1 |
| Oil in cans ignited from fire in building | 2 |
| No data as to character of fire or cause | 16 |
| Total | 190 |

The foregoing table of fire causes indicates that the majority of range oil burner fires are the result of flooding or overflowing and are chargeable directly or indirectly to faulty installation or adjustment. When flooding occurs prior to the lighting of the burner the oil overflows from the vaporizing chambers into the ash pan of the stove and when the burner is lighted this free oil is ignited. This creates a smoke scare, may overheat the stove and smoke pipe and, if dampers are wide open, may ignite sooty accumula-

tions in the chimney. Usually little fire damage results. Of the one hundred and twenty-nine fires attributed to the overflowing or flooding of range oil burners, but eighteen caused a loss to buildings or contents and in only one instance was serious damage done.

Other fires involving the burners themselves and probably chargeable for the most part to improper adjustment or operation have been due to manipulation of valves while the burner is operating, to defects in the burner itself, to accumulations of excess deposits of carbon on the burner and to faulty dampers. Three of these fires involved a loss estimated at $500 or over.

Defective burners as a fire cause appear chiefly in connection with cheap burners having parts constructed of inferior materials which warp after being heated. This disturbs the proper oil level in the burner and leads to flooding. Excess carbon causes improper combustion, resulting in smoke and an occasional flare-up. Faulty dampers permit gases to collect in the stove or stovepipe and "back-firing" has occurred. Under no circumstances should dampers be permitted which may shut off the chimney vent.

The loss of six lives in fires in connection with range oil burners is shown by the fire record to be chargeable to lack of care with the fuel supply. Carelessness in placing the bottle in position on the stand after filling has been responsible for most of the fires involving serious fire damage as well as for most of the loss of life and injuries. In each instance the bottle has been dropped, the neck broken on the side or top of the stove and the oil ignited from the flame of the burner or the hot stove itself.

Glass bottles used as fuel containers should be securely attached to the stand and the stand permanently fastened to the floor, a condition not always found with the cheaper types of equipment. If glass bottles are too close to the stove heat or flames from a flooded burner may crack them and release the oil, a condition responsible for at least one fire.

Improper methods of storage of oil in buildings used as dwellings involve a hazard that has given considerable concern to fire department officials. Storage in excess of ten gallons is usually in 50-gallon drums in the basement. These drums often are not provided with proper vents and may overflow when being filled. Oil is often spilled when the fuel container of the burner is filled from the drum and the so-called self-closing faucets sometimes leak.

In the State of Massachusetts range oil, or kerosene, may be stored in quantities of ten gallons or less without a permit. In general, a square five-gallon light gauge tin can is used for this purpose from which it is very difficult to fill a fuel supply bottle without spilling. These cans are often stored on rear piazzas, particularly upper piazzas of two and three-family houses. As a result of the storage of small quantities of flammable oil in rusty leaking

cans, coupled with careless handling and spilling, a large number of rear hallways and stairways in tenement houses are becoming oil-soaked, ready to do their part in spreading a basement fire upward.

## Typical Range Oil Burner Fires.

The following summaries of range oil burner fires have been selected to present a cross-section of typical fire experience, indicating the potential hazards involved, and showing the character of fires which may be expected. This list of typical fires includes most of those where loss of life or injuries have occurred.

### Fires Involving Range Oil Burners.

HINGHAM, MASS., OCTOBER 25, 1930. A range oil burner had just been installed and was lighted for the first time. The burner was apparently improperly adjusted and the oil overflowed and ignited in the ash pit of the stove. Overheating resulted and the woodwork around the stovepipe was slightly burned.

SALEM, MASS., 1931. A man was badly burned about the face and chest as a result of a flare-up which occurred when he lighted the burner. The oil that he was burning was later analyzed and found to contain a considerable quantity of gasoline.

SPRINGFIELD, MASS., NOVEMBER 5, 1931. The cause of this fire was a red hot stovepipe. It would appear that under certain conditions burners generate a surplus of flammable vapor which may become trapped in the stovepipe because of excess soot deposits or pockets formed at elbows, etc. The installation in question had two 90° elbows located at the top of a five-foot riser pipe, at which point the gases ignited. The fire was confined to the stack and no loss occurred.

MEDFORD, MASS., NOVEMBER 6, 1931. Firemen were occupied for more than an hour as the result of an alarm for a fire in a two-story frame dwelling. The fire started in the ash pan of a kitchen range in which considerable fuel oil had collected. Heavy smoke filled the house, but the fire damage was not heavy.

MEDFORD, MASS., NOVEMBER 16, 1931. Slight damage was done to the dwelling at 39 Exeter Street when the kitchen was set on fire by a range oil burner which got out of control and sent flames high into the room. Firemen quickly extinguished the fire.

PEABODY, MASS., DECEMBER 7, 1931. A man was seriously burned about the head when a kitchen range oil burner "exploded" at his home.

LYNN, MASS., NOVEMBER 6, 1932. When a range oil burner in a dwelling got out of adjustment oil overflowed into the ash pan of the stove. When the burner was lighted this oil ignited, creating a hot fire in the stove. The drafts

were closed and smoke filled the house. The stove overheated, but oil dripping from the ash pan on to the floor did not ignite. The fire department opened the drafts in the smoke pipe and got rid of the smoke and threw ashes on the oil on the floor to prevent ignition. The glass bottle adjacent to the stove was removed to a safer location.

BOSTON, MASS., DECEMBER 2, 1932. Alone in the kitchen of her home on the first floor of a three-story frame dwelling a woman suffered serious burns when her clothing ignited as a result of an "explosion" in a range which contained a range oil burner. It is stated that flaming oil set fire to woodwork near the stove and in attempting to extinguish the flame the woman's clothing ignited. The kitchen was damaged to the extent of $500. The cause of the explosion was not ascertained.

ROWLEY, MASS., DECEMBER 8, 1932. This fire occurred in a rural dwelling. The occupant of the house arose early, started his range oil burner and then returned to bed. Later he was awakened by a crackling noise and smoke. He went to the kitchen, where he found that the oil burner had flooded and that the stove and funnel were red hot. He shut off the burner, but discovered fire burning in the next room and in the partition near the flue.

When the firemen arrived after a two-mile run smoke was coming through the roof and windows. A pumper stream was brought into play promptly and the fire was confined to the partition of origin near the chimney. The loss was estimated at $500.

### Fires Involving Fuel Supply.

ASHLAND, MASS., FEBRUARY 4, 1929. Four persons were burned in a rural dwelling when a three-gallon glass oil bottle attached to a range oil burner broke and the oil ignited from contact with the stove. The bottle had just been filled and was being placed in position when the accident occurred. The resultant fire practically destroyed the dwelling with a loss estimated at $5000.

HARTFORD, CONN., 1930. According to records of the fire department, two losses occurred during the year from fires caused by range oil burners. One of these occurred in a dwelling at 54 Chestnut Street. When the burner was installed in the stove the holes for pipes in the water front were not plugged. The burner overheated and heat or flame shot out of these holes, causing the glass container for fuel oil, located close to the stove, to burst. The fire caused considerable damage to the room, involving a loss of $643.

The other fire with loss occurred at 86 Willow Street when children set fire to a box of waste which was located directly under a glass container for fuel oil in the kitchen. The heat from the flames broke the bottle and the burning oil flowed over the floor of the room. The loss was $575.

SALEM, MASS., 1931. Two fires during the year caused extensive damage as a result of glass fuel oil bottles supplying range oil burners being placed in

closets with clothing, brooms, etc. In both instances the housekeeper lighted a match to determine whether there was oil enough to last until she returned from a shopping tour and then left the house. The matches ignited clothing or other material in the closet and the heat thus generated cracked the bottle and ignited the oil thus released. The burning oil flowed around the closet and room into partitions through cracks between the floor and walls, burning to the second floor before being extinguished.

SALEM, MASS., FEBRUARY 24, 1932, Eugene Pineault, his wife and their two-year-old daughter had a narrow escape from being seriously burned in the kitchen of their home when a bottle of range oil ignited. Mr. Pineault had just refilled the bottle and in doing so had slopped some of the kerosene over the outside, which made it slippery. As he attempted to tip the bottle into its place on the stand, it fell from his hands, hitting the ash pan of the stove, which projected about 12 inches. The bottle broke at the neck and immediately a flash occurred. The burning oil ran on to the floor and created an intense fire which entered the partitions of the room and burned inside the wall to the ceiling.

According to reports, Mrs. Pineault and the baby who were in the room at the time were painfully, though not seriously burned. The fire department was called by neighbors (Pineault trying to extinguish the fire himself) and neighbors also rescued two children who were asleep in rooms adjoining the kitchen, which could not be reached from within. The loss to the dwelling and its contents amounted to $1500.

HOLBROOK, MASS., APRIL 11, 1932. Two children were fatally burned and their mother severely burned when a glass oil container for a range oil burner was broken and the contents ignited. The accident occurred when the mother was replacing the oil container after it had been filled. As she was about to replace the container, a glass bottle of two gallons capacity, on the stand she noticed a leak about the cap.

She attempted to place it on the floor in order to screw the cap on more securely, but the bottle was slippery from the kerosene on the outside and it slipped from her grasp, broke against the hot stove and the oil ignited. The resulting flash enveloped her and the two children who were near by. The house was badly damaged.

PAWTUCKET, R. I., NOVEMBER 22, 1932. A woman was severely burned while handling fuel for her range oil burner. She had filled the two-gallon glass container and instead of taking it around the stove she lifted it over the top. Oil on her hands and the bottle made the latter slippery and she dropped it on the top of the hot stove, where it broke and the oil ignited. She was drenched with burning oil and ran into an adjacent bedroom, where her husband extinguished the flames by wrapping her in a blanket.

Her husband carried her from the house to his automobile and drove to a physician, failing to notice in his excitement that the bed had started to burn. A few minutes later a tenant on the third floor smelled smoke and on investigation found the room in flames. The fire department was summoned and confined the fire to the room. The woman died about three weeks later.

BOSTON, MASS., NOVEMBER 27, 1932. The glass fuel bottle of a range oil burner was broken by children and the contents were ignited by heat from the kitchen range.

MEDFORD, MASS., JANUARY 21, 1933. A woman had returned to her kitchen from the basement where she had filled a glass oil container with range oil. As she attempted to place the container on the stand she hit the bottle against the stove, where it broke. The oil flowed into the ash pan and ignited, setting fire to her clothing. Her daughter ran to her assistance and smothered the fire in the clothing with a blanket, but not before the mother was so badly burned that she later died. No damage was done to the house, the oil having burned out when the firemen arrived.

PAWTUCKET, R. I., MARCH 18, 1933. Two persons lost their lives and a baby was severely burned when range oil was ignited as the result of dropping a glass fuel oil bottle on a hot stove. As the fire department officials reconstruct the story of the disaster it appears that as Mrs Bodeur was placing the bottle on the stand a few drops of oil spattered on to the hot stove and ignited. The burning oil in turn ignited her clothing and it is thought she started to run away, still carrying the bottle. It is believed that she dropped the bottle, which broke, and the rest of the oil ignited.

Trapped by the flames, she screamed for help and her daughter rushed to her assistance and tried to beat out the fire. In so doing, the daughter's clothing caught fire and in a hysterical condition the girl ran from the house, a human torch. Neighbors hearing the screams and seeing the girl running down the street came to the assistance of the victims, extinguishing the fire in their clothing.

In the meantime the fire department had been summoned. On their arrival spectators told them that a baby sleeping in a carriage in a room adjoining the kitchen was still in the house. The firemen fought their way in and rescued the baby, but not before it was severely burned. The fire was confined to the kitchen and small part of the bedroom where the baby was sleeping. The three victims were taken to a hospital, where the mother and daughter died the following day as a result of their burns.

### Fires Involving Storage of Oil.

LYNN, MASS., DECEMBER 8, 1931. This fire occurred in the basement of a dwelling while a tank was being filled with range oil. The driver of the tank truck apparently did not properly attach the hose from the truck to the

tank and when the oil started to flow the coupling worked loose, permitting the oil to flow on to the floor. When the oil came in contact with live coals in the heater it flashed back. The driver, who was outside the house when the fire occurred, tried to extinguish it and was burned about the face in the attempt. A baby asleep in his carriage upstairs was overcome by smoke which filled the house. He was rescued by a fireman. The loss to the dwelling was $300.

HARTFORD, CONN., APRIL 28, 1932. This fire occurred in a basement used in part for the storage of range oil. The drum used for the storage of this oil was equipped with a faucet which leaked, allowing the area in the vicinity to become oil soaked. Cloths were used to wipe off the bottle after filling and these old cloths were thrown around on the floor. The basement was not provided with light and a man lighted a match to see. The match was carelessly thrown into the oil-soaked cloths, causing a fire which resulted in a loss of $610.

SOMERVILLE, MASS., FEBRUARY 4, 1933. This fire involved a two and one-half story frame dwelling house. The fire started under the rear piazza, involving same, and extended up the rear of the structure and through the rear windows and roof coping into the cockloft before the arrival of the fire department.

The fire had its origin from a live match carelessly tossed into a pile of dried leaves, which covered a supply of vegetables under the rear piazza. Adjacent to the leaves were two 5-gallon cans of range oil. In the opinion of fire department officials the presence of this oil contributed to the intensity and rapid spread of the fire. Loss to building and contents was estimated at $4000.

SOMERVILLE, MASS., FEBRUARY 6, 1933. Fire occurred in a three-story frame tenement house in a congested group of similar type buildings. The fire started on the rear piazza of the third floor and extended into the roof space and third floor apartment through an open window before the arrival of the fire department.

On the piazza where the fire originated there were two 5-gallon cans of range oil, both of which "exploded." The rapidity of the spread of the fire would seem to indicate that the woodwork was apparently well oil-soaked. The cause of the fire was determined to have been due to a lighted cigarette stub thrown on to the oil-soaked piazza. The estimated loss to the building and contents was $2150.

# Baltimore Armory Fires.

Report by R. W. Neal and C. V. Gordon,
Association of Fire Underwriters of Baltimore City (Member N.F.P.A.)

For the second time within five months the Fifth Regiment Armory of the Maryland National Guard at Baltimore was visited on January 13, 1933 by a fire involving a loss in excess of $100,000.

The first fire occurred on August 30, 1932, and destroyed practically the entire contents of the basement and damaged the beams and joists supporting the main floor to such extent that replacement was necessary. The loss by this fire was estimated at about $125,000. The fire of January 13 had its origin in the upper section of the building just below the roof, which was of wood sheathing covered with sheet metal and supported by steel trusses. The entire roof, including the structural steel, was practically a total loss, and considerable damage was done to officers' quarters and company rooms. The loss to the building was approximately $430,000, with considerable loss to the contents.

## Property Involved.

The armory in which the fire occurred occupied the block bounded by West Hoffman Street, Preston Street, Jenkins Alley and Mason Alley, just outside the business district of the city. It was 350 ft. long and 280 ft. wide, and had a floor area of 98,000 sq. ft. A basement having an area of 44,000 sq. ft. extended under part of the building. A drill shed took up most of the space above the basement, this section being open to the roof with a maximum height of 125 ft. to the peak of the monitor skylight. A series of rooms used for company rooms and for officers' quarters surrounded the drill hall.

The exterior walls were of heavy masonry construction. The main floor was of wood on concrete, and the portion which burned out during the first fire was replaced with the same type of construction. Basement and sub-basement floors were of concrete. The second and third floors in the sections surrounding the drill hall were of ordinary joist construction supported by unprotected steel work. Floor openings, consisting of stairways, were part open and part enclosed with wood lath and plaster.

The roof, supported on unprotected steel truss arches, was of ordinary wood sheathing covered with sheet metal. The flat portions were covered with slag roofing.

The basement was occupied as a storeroom for field equipment, wearing apparel, cots, small arms ammunition, etc., although after the August fire most of the ammunition was removed. An unused bowling alley and a rifle range were also in the basement. The heating plant and workshop were in a small sub-basement.

First aid protection consisted of two 2½-gallon soda-acid extinguishers and a 50-gallon soda-acid extinguisher on wheels in the basement, and two 2½-gallon soda-acid extinguishers on the first floor. In addition, there were four 2-inch standpipes supplied from a 4-inch city main with 50 ft. of 2-inch hose and playpipe at each outlet. There was no watchman.

## The Fire of August 30, 1932.

The fire of August 30, 1932, originated in the basement on the Preston Street side of the building. This section of the basement was 270 ft. long by 40 ft. wide, the center portion of which was occupied by a number of frame enclosed company storerooms. An open aisle extended along the exterior wall and another aisle was at the rear of the storerooms. The rear aisle was piled solid with tents, tent poles, field piece carriages and small arms ammunition.

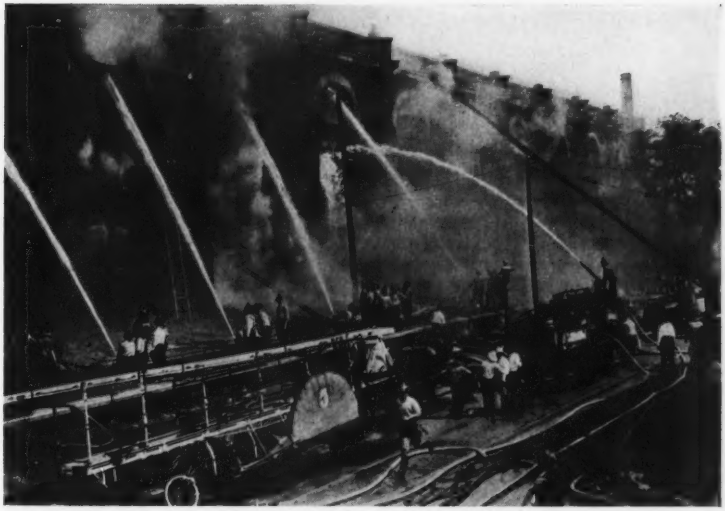
The first notification of the fire came from a charwoman, who reported that she smelled smoke. An investigation was immediately made and the fire located in one of the storerooms near the east end of the basement. The fire had apparently been smouldering for some time in this locked room, not bursting into flame due to the absence of sufficient air to support rapid combustion. With the opening of the door this condition immediately changed, and it is stated that the entire room seemed to burst into flame.

While one of the men ran to the nearest fire alarm box others used chemical extinguishers in a futile attempt to control the fire. A line of hose was stretched from the standpipe, but no water reached the fire due to numerous kinks in the line.

### Progress and Extent of the Fire.

The first alarm was received at fire department headquarters at 8:46 A.M., about five minutes after smoke was first detected. The first battalion chief to arrive appreciated the seriousness of the situation and immediately transmitted a second alarm. The fire spread rapidly, with the result that seven additional alarms were sounded, bringing to the scene of the fire two deputy chiefs, eight battalion chiefs, 31 engine companies, 10 truck companies, four high pressure hose companies, seven chemical companies and a water tower.

The first companies to arrive carried hose lines into the basement through the doors at each end, but were unable to reach the storeroom in which the fire originated due to heat and smoke. With the arrival of additional companies numerous streams were directed through windows, but these streams were only partially effective due to partitions which ran almost the entire length of the basement. It was not long before the fire burned through the rear partition of the room of origin into the narrow corridor which ran the length of the basement and was filled with combustible materials. The fire spread rapidly through this corridor, due to the fact that the ends only were



*Keystone-Underwood.*

**Fifth Regiment Armory, Baltimore, fire of August 30, 1932, showing hose streams in use to prevent spread of fire to upper portions of building after it had broken through the drill hall floor.**

accessible to the fire department, and soon involved the other storerooms. Holes were cut through the drill shed floor above the basement to permit the use of cellar pipes, but these, too, were of limited value due to partitions.

The fire was difficult to fight. The firemen were handicapped not only by the partitions and excessive quantities of combustible materials not readily accessible, but by dense smoke, which resulted in twenty-six firemen being overcome, and the ever present danger of exploding ammunition.

When the fire finally broke through the first floor, hose streams, together with a water tower, were placed in service to prevent its spread over the floor. At this time there was approximately 10,000 to 12,000 gallons of water per minute being thrown into the section where the fire was burning. The fire was finally extinguished about 3 P.M.

## Cause and Loss.

Although the cause of the fire could not be definitely determined, smoking appears to be the most probable cause. The night previous to the fire, drills were held in the armory and the fire originated in the storeroom of a company which participated. Practically the entire contents of the Preston Street basement were destroyed, and the beams and joists supporting the first floor were damaged to such an extent that they had to be replaced. The loss was estimated at $125,000.

## The Fire of January 13, 1933.

The exact point of origin of the second fire is difficult to determine, but from the statements made by eyewitnesses to the effect that the fire first broke through the roof at the left of the main entrance, it is thought to have originated near this point. This section, occupied as locker rooms, had partitions of light wallboard. It had been in use until nearly midnight on the night of the fire.

The fire was first noticed by persons outside the building, who observed it through the monitor skylight on top of the roof, and sounded an alarm from a near-by street box at 1:50 A.M.

### Progress and Extent of Fire.

The battalion chief who responded to the first alarm reached the scene in approximately three minutes. He noted the fire spreading through the monitor skylight and, after waiting for the fire alarm circuit to clear of signals being transmitted from adjacent boxes pulled by outsiders, sounded a combination sixth alarm at 1:55 A.M. When he returned to the building the fire was breaking through the flat roof east of the main entrance and almost the entire arched roof was involved. On their arrival the firemen were unable to gain

*International.*

**Fire of January 13, 1933, Fifth Regiment Armory, Baltimore. The firemen were hampered by the inaccessibility of the fire, which started on the third floor and extended to the wood roof. The fire spread rapidly and within ten minutes of the sounding of the alarm the entire roof was involved.**

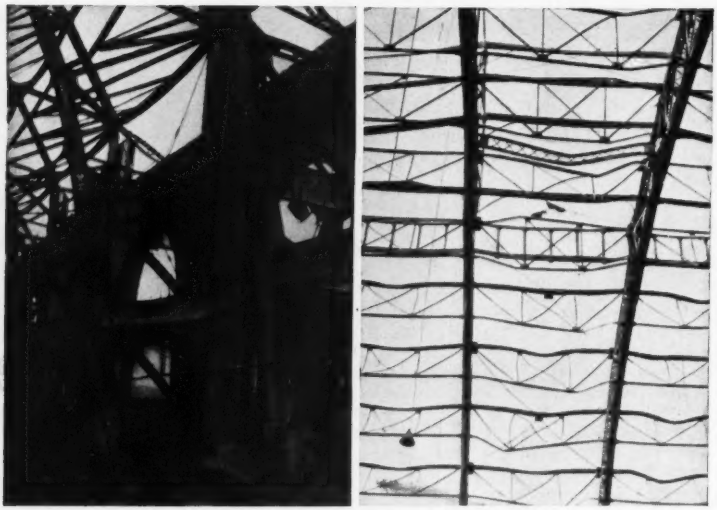
**Ruins of the Baltimore Armory, showing the complete destruction of the roof, which was of ordinary wood sheathing covered with sheet metal and supported on unprotected steel truss arches.**

entrance to the armory on account of locked doors. Fortunately, one of the officers of the National Guard happened by who unlocked a lower door, went inside and opened the main entrance. After sizing up the situation inside the building, the battalion chief transmitted a combination seventh and eighth alarm at 2:04 A.M., and the ninth at 2:09 A.M.

Chief Travers of the fire department responded on the sixth alarm. He states that on his arrival the entire metal covering of the roof was bright red in color, indicating that the wood sheathing underneath was well involved. He found burning débris dropping from the high arched roof to the floor below and ordered the firemen in the building to stay under the balconies which surrounded the drill hall. It was impossible to reach the roof (125 ft. above the drill floor) with hose streams, and the efforts of the firemen were directed to extinguish the burning sheathing which dropped to the floor. Other hose streams were used outside the building and in the company rooms and officers' quarters. The water tower, placed in front of the main entrance, covered the sections adjoining. Hose streams were also directed from the roofs of dwellings across twenty-foot wide alleys east and west of the armory, but these streams were ineffective.

After the steel skeleton arches of the roof cooled and the danger of collapse was reduced, the firemen on the inside completely extinguished the fire in the company rooms and on the balcony. The fire department was successful in preventing the spread of fire to the basement and surrounding properties.

Flying brands created a serious problem, and the tenth alarm was sounded at 2:44 A.M. for more companies to patrol the surrounding district, and the eleventh at 3:43 A.M. for a fire in an old shingled roof two blocks dis-



**Left: Interior of drill hall, showing effect of fire on steel work and complete destruction of company rooms and officers' quarters. Right: View looking up at steel truss arches. Note severe distortion of steel roof members.**

tant. The general use of non-combustible roof coverings in this old residential section materially reduced the hazard from flying brands.

The firemen were hampered by freezing temperatures and a stiff breeze from the northeast, which made the fire more intense on the south or Preston Street side. The first floor and roof on this side were difficult of access, due to the slope of the land which brought the basement floor level above the street. The small size and number of entrances and windows also obstructed the firemen in their efforts.

The remainder of the city was well protected by the fire department during this fire, due to the new system of transferring companies from the outlying districts and placing in service sixteen reserve companies.

### Alarms and Apparatus Responding.

*Alarms:* Bolton and Hoffman Streets—Box No. 3524—first alarm 1:50 A.M., combination sixth alarm 1:55 A.M.; Park Avenue and Preston Street—Box No. 357—seventh and eighth alarms 2:04 A.M., ninth alarm 2:09 A.M., tenth alarm 2:44 A.M.; Biddle Street and Linden Avenue—Box No. 35—eleventh alarm 3:43 A.M.

*Apparatus Responding:* Thirty-five engine companies, 10 truck companies, one hose company, one water tower, 8 battalion chiefs, two deputy chiefs, chief engineer.

*Remaining Apparatus in Quarters:* Thirteen engine companies; 10 truck companies, four high pressure hose companies, three chemical companies, two battalion chiefs.

*Reserve Companies Placed in Service in Quarters:* Twelve engine companies, four truck companies.

## Cause and Loss.

The cause of the fire has not been determined, due to the extent of the fire and the destruction of any tangible evidence. While official investigations by the National Guard and police department found the probable cause to be defective electrical wiring, this theory appears to be discredited by the fact that practically all of the electrical equipment was found shut off at the main switches. There was no wiring on the wood roof, it being installed inside the lower chord of the steel trusses. As these lower chords were ten feet below those supporting the wood sheathing, ignition of the roof from an electrical short circuit would appear impossible.

In view of the fact that a drill and social affair had been held in the evening prior to the fire and the locker rooms near the point of origin of the fire had been used, it would seem reasonable to assume that a carelessly thrown match or cigarette was responsible for its origin.

The entire roof, including the structural steel, was practically a total loss. The steel arches suffered extreme expansion and contraction and, evidently due to the velocity of the wind, they moved to the south (see accompanying pictures of base of steel arches). The interior walls, faced with stone, were intact, but the high walls at the end of the arched roof required replacement. The concrete under the main floor appeared to be in good condition and the basements suffered only water damage. The loss to the building was $431,354. The contents loss, exact figures for which are not available, was considerable.

# Brewery Fire Record.

Prior to 1919 brewing and malting were important industries in the United States. The advent of prohibition severely curtailed operations, but with the recent legislation permitting beer the rejuvenation of the industry seems assured.

According to statistics of the U. S. Department of Commerce, in 1914 there were 1250 breweries in operation, employing 62,070 wage earners and producing 2,048,236,412 gallons of malt liquors valued at $442,149,000. By 1921 the number of breweries had shrunk to 531 and the value of the product decreased to $122,050,000. The investment in the industry in 1914 was estimated at $800,000,000 in round figures and it was testified before a Congressional Committee that $360,000,000 would have to be expended in the next two years to put the industry back on the same basis.

The potential fire hazards of breweries have changed but little since pre-prohibition days. The production of "near beer" has continued by the same process, the only difference being that the excess alcohol has been distilled out after brewing by a supplementary operation. A full discussion of the processes, hazards and protection of breweries and malt houses was published in the N.F.P.A. QUARTERLY for October 1915, from which much of the data that follow has been extracted. This discussion also included a statistical summary of the fire record of these occupancies to that date.

## Processes.

Beer is a fermented alcoholic drink intended for consumption during the after-fermentation, while still charged with carbon dioxide. It is made from sprouted grain (malt), starchy materials, and hops. The malt is generally barley, as this grain yields the largest percentage of diastase and affords the richest, best flavored beer. The starchy material is derived from unmalted rice or other grain. The manufacture of beer involves three principal operations: malting, grinding and brewing.

The process of malting consists in so changing the chemical composition of the contents of the barley grains as to render them soluble in water, producing thereby a liquid which can afterwards be subjected to fermentation. The barley is first steeped in water to soften the husks, in consequence of which the barley swells. It is then placed on the floor of the malt house, where heating and germination take place. From the proteids in the malt there is developed a substance called diastase, which has the property later of attacking the starch and converting it into maltose and dextrin, which are soluble products.

When the process of germination reaches a certain point the barley grains are spread over a large floor, turned over from time to time to pre-

vent overheating, and germination is permitted to continue. When the proper point is reached further germination is stopped by subjecting the grain to kiln drying.

Following the drying process the grain, now known as malt, is usually placed in storage bins from which it flows to scale hoppers and thence to cleaners, where dust and foreign matter are removed. The cleaned malt is passed to the malt mill, where it is ground. The object is not to grind as finely as possible, but to crush each grain thoroughly so as to permit of the ready attack of the starch by the diastase when water is added, and yet to bring about as little disintegration as possible of the husk of the grain which is needed to assist filtration in the mash.

From the ground malt bins the malt passes to a weighing machine and then to the processes of brewing, consisting of various operations which convert it into beer. The crushed malt is extracted in hot water, when the diastase completes its action in changing the starch to dextrin and maltose.

After the malt has been sufficiently treated, the solution is drawn off, and this constitutes the wort. The remaining grains are subjected to a treatment with water to obtain as large a portion of soluble matter as possible, the worts are united, hops are added and the wort is complete. It is then rapidly cooled to the proper temperature, the yeast is added and fermentation proceeds. During the fermentation the yeast develops, attacks the sugar and liberates carbonic acid gas and alcohol. The rise of the carbonic acid gas through the liquid causes motion and the liquid is set to work.

When the fermentation is complete the beer is drawn off and stored in suitable vats that it may properly age and undergo slow after-fermentation and ripening, and the liquid become clarified. The sediment of the yeast is found in the bottom of the vessels in the case of lager beer, while in the case of ale the yeast is found in the form of scum on the top. Finally the beer is filtered and placed in barrels or bottles, the latter being generally pasteurized.

## Hazards.

The following fire record shows the principal points of fire hazard, indicated by fire experience:

MALT DRYING AND STORAGE: The hazards of a malt elevator are similar to those of a grain elevator, including the dust explosion hazard, and similar precautions are indicated. Fresh malt is shown by the record to be subject to spontaneous ignition.

The process of drying the malt consists of passing hot air over the grain by means of fans. The air is heated by various means to a temperature of 120 to 130 degrees Fahrenheit, being increased to 150 to 220 degrees in the final heating. This involves a hazard that is obvious. Malt kiln houses are usually separated from the malt house by a fire wall.

In the older breweries many fires were chargeable to the old-fashioned kiln with tunnel stokehole and hot air chamber behind, the floor of the latter often being covered with three or four inches of dust and chaff. The hazard is reduced by the modern kiln with two or more furnaces and a central hot air shaft, the building being constructed of fire-resistive material and detached from balance of plant.

CLEANING AND GRINDING: From the scales the malt passes through cleaning reels and thence to the grinding mills. This is the most hazardous operation in the brewery proper, due to the possibility of friction resulting from clogging of the mills and due also to the dusty atmosphere. Ground malt dust is said to be more readily ignited than wheat flour dust.

PITCHING: The demand for bottled beer has reduced one hazard of a brewery, for in many instances the use of kegs has been entirely abandoned, thus eliminating the pitching hazard.

Pitching consists of covering the interior of kegs with a coat of pitch to prevent the beer from coming in contact with the wood, thus affecting the flavor. Ordinary brewers' pitch, most commonly used, is purified resin softened or made pliable by melting with some rosin oil, cottonseed oil or paraffin.

The process of pitching in the older breweries was often located in the cooper shop, or adjacent thereto, in a cheaply constructed shed, which seriously exposed the whole building. The old-fashioned pitch kettles were generally of iron set over coal-fired brick furnaces, and insufficient care was frequently given to the matter of secure foundation and protection of surrounding floor. It was not unusual to find them located in pits. The flue pipe from the hood over the kettle often extended through the roof without adequate protection for the surrounding woodwork. Pitching sheds were frequently ignited by overflowing of pitch, or the ignition of vapors and it is obvious that pitch kettles should not be left alone when in use. Fires in pitching rooms, if built of wood, are apt to be flash fires, due to the fact that the woodwork in the room becomes saturated with pitch from flammable vapors that constantly arise in the process.

Breweries make extensive use of mechanical refrigeration equipment, with the hazards usual to refrigeration processes. However, only one of the fires included in this record occurred in connection with the refrigeration process and this is not definitely charged to refrigeration equipment.

### Fire Record.

The files of the N.F.P.A. Department of Fire Record contain reports on 222 brewery and malt house fires which have been recorded since 1904, including 21 reported between July 1, 1919, and Jan. 1, 1933. While this record by no means includes all brewery fires occurring during this period, the

number is sufficient to indicate the potential fire hazards of the industry and to point the way to adequate provisions for their safeguarding. The previous detailed fire record for this occupancy was published in the QUARTERLY for July 1912 and was based on 100 fires reported up to that time.

The tables which follow indicate the causes of brewery and malt house fires, their point of origin and the resultant loss. These fires have been divided into two groups, those due to special hazard causes and those due to common hazards. The special hazard fires have been further subdivided as to processes in so far as it was possible to do so.

The greatest number of fires were due to common causes, these amounting to 48.2 per cent of all fires of known origin. The principal causes were careless smoking, electrical defects and sparks from locomotives. These three causes account for approximately 43 per cent of all fires due to common hazards.

Special hazards were responsible for 44.8 per cent of all fires of known origin. Of these special hazard fires 35, or 46 per cent, were chargeable to the operation of pitching; 22, or 29 per cent, occurred in malt storage sections or in connection with kiln drying; and 19, or 25 per cent, were attributed to cleaning and grinding processes.

## Point of Origin of Brewery Fires.

| | | No. Fires |
|---|---|---|
| **Operating Departments** | | 117 |
| Pitching room | 35 | |
| Malt mill | 20 | |
| Malt bins or storage | 14 | |
| Elevator | 11 | |
| Malt dryer or kiln | 10 | |
| Vat room | 8 | |
| Bottling room | 8 | |
| Cold storage room | 6 | |
| Hop storage | 5 | |
| **Other Sections** | | 71 |
| Roof | 21 | |
| Boiler house or engine room | 17 | |
| General storerooms | 12 | |
| Roof space | 7 | |
| Office | 5 | |
| Outside walls (exposure fires) | 5 | |
| Locker rooms | 4 | |
| Miscellaneous known locations | | 20 |
| No data as to location | | 14 |
| Total Number of Fires | | 222 |

## Brewery Fire Causes.

| | | No. of Fires | Per Cent of Known Causes |
|---|---|---|---|
| **Special Hazard Causes** | | | |
| Malt Storage and Drying | | 22 | 12.8 |
| Spontaneous ignition of grain or malt | 8 | | |
| Friction in elevator leg | 2 | | |
| Friction in dryer fan or motor | 3 | | |
| Spontaneous ignition of old malt bags | 1 | | |
| Miscellaneous dryer fires | 8 | | |
| Malt Cleaning and Grinding | | 19 | 11.0 |
| Foreign material in grinder | 9 | | |
| Explosion of malt dust in grinder | 6 | | |
| Ignition of malt dust in cleaner | 3 | | |
| Open flame ignited malt dust | 1 | | |
| Varnishing and Pitching Vats and Kegs | | 35 | 20.4 |
| Pitch in kettle boiled over | 10 | | |
| Pitch in kettle ignited | 8 | | |
| Varnish vapor in vats ignited | 4 | | |
| Fumes from pitch kettle ignited | 2 | | |
| Stack from pitch kettle overheated | 3 | | |
| Miscellaneous pitch fires | 8 | | |
| Total Special Hazard Causes | | 76 | 44.2 |
| **Common Causes** | | | |
| Smoking—Matches | 13 | | |
| Electrical causes | 12 | | |
| Sparks from stacks or locomotives | 11 | | |
| Gasoline or kerosene blow torch | 5 | | |
| Thawing water pipes | 4 | | |
| Lightning | 4 | | |
| Spontaneous ignition—painter's material | 4 | | |
| Spontaneous ignition—oily waste | 3 | | |
| Spontaneous ignition—soft coal | 3 | | |
| Miscellaneous known causes | 24 | | |
| Total Common Causes | | 83 | 48.2 |
| Incendiary | | 3 | 1.7 |
| Exposure | | 10 | 5.9 |
| Total Known Causes | | 172 | 100.0 |
| Unknown | | 50 | |
| Total Number of Fires | | 222 | |

The loss record in brewery fires seems to indicate that, as a class, the nature of the hazards involved, coupled with the type of construction, has resulted in loss averages lower than those usually prevailing in occupancy

classes that are so largely unsprinklered. In 46.8 per cent of the fires studied the loss was reported as small, or less than $1000, and 65.3 per cent were less than $10,000. In 23.4 per cent of the fires recorded the loss was in excess of $10,000, or reported as large. There were 25 fires or 11.3 per cent where no definite loss was reported.

### Losses in Brewery Fires.

| | No. of Fires | % |
|---|---|---|
| "Small" | 45 | 20.3 |
| Less than $1000 | 59 | 26.5 |
| $1000 to $9999 | 41 | 18.5 |
| $10,000 to $49,999 | 33 | 14.8 |
| Over $50,000 | 9 | 4.1 |
| Large | 10 | 4.5 |
| No data | 25 | 11.3 |
| Total | 222 | 100.0 |

### Sprinkler Fire Record.

Comparatively few breweries in the country have been equipped with automatic sprinkler systems. In all instances that are on record in N.F.P.A. files, where fires occurred in sprinklered breweries, the action of the sprinklers has been satisfactory and has demonstrated the value of such equipment.

| | No. of Fires | % |
|---|---|---|
| Extinguished Fire | 5 | 83.5 |
| Held Fire in Check | 1 | 16.5 |
| Total | 6 | 100.0 |

All of these fires in sprinklered property occasioned but small losses.

## A Dust Explosion Hazard.

A new dust explosion hazard was experienced by the fire department of Lexington, Kentucky, recently. A fire in a small negro dwelling appeared to have been started by an explosion. Investigation developed that the occupants had been attempting to kill mosquitoes, using the following procedure: A handful of flour was thrown in the air and, while suspended, the cloud of flour dust would be ignited by a torch made of a twisted newspaper. The result would be a puff or explosion which was supposed to kill the mosquitoes.

# Gas Holder Explosion.

## Neunkirchen, Germany, February 10, 1933.

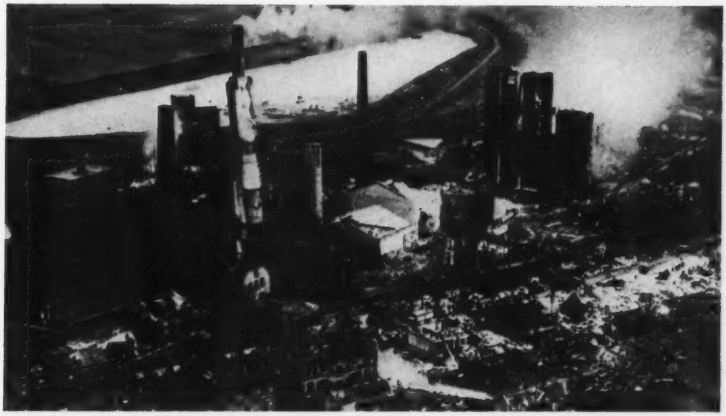
Sixty-five persons were killed, several hundred others were injured and severe property damage resulted when a large gas holder of the Neunkirchen Iron Works at Neunkirchen, in the Saar District in Germany, exploded on February 10, 1933. Scarcely a building in the city escaped without damage, and window glass was shattered in outlying communities several miles away. About twenty houses located in the immediate vicinity of the gas holder were blown from their foundations and completely demolished. Fifty others farther away were damaged beyond repair. Several sections of the plant were badly damaged and operations had to be shut down. Highways leading from the city were choked with débris and the roadbed of the railroad was rendered impassable.

*Feuershutz.*

**The gas holder before the explosion. Inside was a floating disc separating the gas in the partially filled holder from the air space above. The explosion is attributed to escape of gas into the air space.**

The wrecked gas holder was used to store gas manufactured at the coke plant of the Neunkirchen Iron Works. It was the third largest in Germany, having a diameter of 164 feet, a height of 279 feet and a capacity of approximately 4½ million cubic feet of gas. It had been in operation since 1931. The construction and operation of this gasometer was according to the so-

NOTE: This report has been prepared from data furnished by Chief Petersen of the Düsseldorf Fire Brigade, supplemented by data extracted from "Feuershutz" the official publication of the German Fire Engineers Association.—ED.



*International.*

**General view of plant at Neunkirchen, Germany, where 65 persons were killed by a gas explosion, showing wreckage of dwellings in the foreground. The wreckage of the gas holder may be seen at the right of this picture.**

called "dry system" and it did not, like most holders, consist of a movable bell, closed below by water. Instead, it was a stationary vertical tank of sheet steel, roofed, and of a size which corresponded with the maximum gas contents required. Inside this vertical cylinder, and below a fixed roof, was a huge disc-shaped cover so arranged as to rise or sink as the gas contents of the tank increased or diminished.

Gas tightness depended upon a tight packing at the sliding contact between the disc and the inner wall of the tank. The disc was guided by rollers. At its outer edge was a ring-shaped cup, with a packing ring filled with tar oil pressed against the wall of the container by means of levers and counter-weights. Any of the packing oil that leaked out during the movement of the disc was collected at the bottom of the tank and returned by means of automatic pumps.

The use of this type of tank in Germany has been increasing due to certain advantages which it is thought to have over the "wet" type. The principal advantages are, a reduction in total weight and the elimination of the water storage basin, thus permitting a less expensive foundation.

On the other hand this type of construction calls for more careful operating supervision, particularly in regard to the possible formation of an explosive gas-air mixture in the space above the disc. Although measures have been taken in the construction of the tanks to obviate possibility of gas leaks and the elimination of sparks in the interior of tanks, a slight canting of the disc would release the gas into the chamber above. This disaster, like the explosion of a similar tank at Posen, Poland, in 1926 (QUAR-

*International.*

**Airplane view, showing complete demolition of the gas holder (left) and dwellings (right).**

TERLY January 1927, page 287), shows that in spite of strict supervision explosive gas mixtures may form and a serious disaster result.

At the time of the explosion the gas holder was in excellent operative condition and contained about 525,000 cubic feet of gas. It was inspected three times daily. The pressure regulators in the office indicated no abnormal condition of any sort, so it would appear that the disc was functioning properly.

While the exact cause of the explosion has not been officially determined, various theories as to its origin have been advanced. The fact that a few days prior to the explosion some cutting and welding work was being performed on a by-pass of the tank for the purposes of inserting expansion sleeves gave rise to the rumor that these operations were responsible. This work, however, had been terminated on the day of the disaster, although a few men were still engaged in flange work near the tank when the explosion occurred. Had welding operations been in progress it is doubtful whether they would have caused the explosion, for in dry gas containers there is normally no escape of gas and the use of open flames in the vicinity of this type gas holder is ordinarily permitted.

According to statements of eyewitnesses the first indication of trouble was a detonation of medium severity followed by a jet of flame close to the tank, rising to a height of more than 200 feet. It is assumed that this flame heated a section of the tank, causing it to expand, thus locking the disc and permitting the oil packing to run out. This permitted the gas to flow into the space above the disc, forming an explosive mixture of gas and air, which ignited from the red hot wall of the tank. A terrific explosion resulted.

The primary source of ignition is not definite, but a preliminary investigation indicated that leaks had existed in a pipe conduit near the gas holder, which could have formed an explosive mixture which might readily have been ignited by welding operations or a spark struck by a hammer.

The force of the explosion appears to have emanated from the lateral walls of the tank itself as is evidenced by the destruction of the surrounding property. The violence of the explosion is shown by the fact that pieces of 3-inch pipe were thrown a distance of more than a mile. The streets adjacent to the container were filled with metal débris. All structures in the immediate vicinity of the gas holder were wrecked.

*International.*

**Typical street scene after the explosion. All near-by dwellings were demolished and some buildings damaged at distances of more than a mile from the center of the explosion.**

# Fires in Which There Was Loss of Life.

Since the publication of the January QUARTERLY, the N.F.P.A. Department of Fire Record has received from various sources 195 reports of fires in which loss of life has occurred. A total of 313 lives were lost in fires included in this tabulation. Not included in the following tables are thirteen fires which have occurred outside of the United States and Canada, causing a loss of 269 lives.

## Causes of Loss of Life, January-March, 1933.

*Fatalities classified according to the immediate cause of the loss of life rather than according to the cause of the fire.*

| Cause | Men | Women | Children | Total |
|---|---|---|---|---|
| Airplane fires | 12 | 1 | 0 | 13 |
| Airplane crashed on house | 7 | 2 | 4 | 13 |
| Automobile fires | 8 | 0 | 0 | 8 |
| Children alone in house | 0 | 0 | 10 | 10 |
| Clothing ignited—boiling over of lard on stove | 0 | 1 | 0 | 1 |
| Clothing ignited—bonfire, grass, or rubbish | 1 | 1 | 2 | 4 |
| Clothing ignited—candle or torch | 2 | 0 | 0 | 2 |
| Clothing ignited—electric heaters | 0 | 0 | 2 | 2 |
| Clothing ignited—electric iron | 0 | 1 | 0 | 1 |
| Clothing ignited—electric toy | 0 | 0 | 1 | 1 |
| Clothing ignited—fireplace | 1 | 3 | 5 | 9 |
| Clothing ignited—furnace or stoves | 1 | 6 | 8 | 15 |
| Clothing ignited—kerosene stove or heater | 0 | 1 | 2 | 3 |
| Clothing ignited—murder intent | 1 | 0 | 0 | 1 |
| Clothing ignited—range oil burner | 0 | 3 | 0 | 3 |
| Electrical burns | 2 | 0 | 0 | 2 |
| Escaping from burning ship | 2 | 0 | 0 | 2 |
| Explosion—blasting or gun powder | 2 | 1 | 2 | 5 |
| Explosion—coal gas in hold of ship | 1 | 0 | 0 | 1 |
| Explosion—evaporator tank | 1 | 0 | 0 | 1 |
| Explosion—gasoline stove | 1 | 2 | 0 | 3 |
| Explosion—gasoline vapor | 6 | 1 | 0 | 7 |
| Explosion—gasoline vapor in boat | 1 | 0 | 0 | 1 |
| Explosion—illuminating gas | 2 | 1 | 0 | 3 |
| Explosion—illuminating gas (suicide intent) | 1 | 0 | 0 | 1 |
| Explosion—kerosene oil stove or lamp | 1 | 3 | 1 | 5 |
| Explosion—oil refinery | 5 | 0 | 0 | 5 |
| Explosion—probably incendiary | 0 | 1 | 0 | 1 |
| Fire fighting | 22 | 0 | 0 | 22 |
| Gasoline used to start fire | 1 | 0 | 5 | 6 |
| Ignition of flammable liquids or vapors | 2 | 2 | 1 | 5 |
| Kerosene used to start fire | 7 | 3 | 9 | 19 |
| Overcome by smoke—suffocation | 5 | 1 | 1 | 7 |
| Railroad collision | 5 | 0 | 0 | 5 |
| Re-entering burning building | 1 | 1 | 0 | 2 |
| Response to alarms | 8 | 0 | 0 | 8 |
| Shock or after effects of fire | 0 | 1 | 0 | 1 |
| Smoking in bed | 6 | 3 | 0 | 9 |
| Trapped in burning buildings | 40 | 35 | 30 | 105 |
| Trapped while starting incendiary fire | 1 | 0 | 0 | 1 |
| Total | 156 | 74 | 83 | 313 |

## Loss of Life Fires, January-March, 1933.*

*This is a typical rather than a complete record, presented to show the conditions under which loss of life occurs, that they may be known and guarded against. The total loss of life by fire in the United States is estimated at 10,000 annually.*

| Class of Fire | No. Fires | Lives Lost Men | Women | Children | Total |
|---|---|---|---|---|---|
| Airplane fires | 7 | 12 | 1 | 0 | 13 |
| Apartments, hotels, lodgings, tenements, etc. | 25 | 28 | 11 | 9 | 48 |
| Automobile fires | 5 | 8 | 0 | 0 | 8 |
| Barns and stables | 2 | 1 | 0 | 2 | 3 |
| Dwellings—Rural | 69 | 30 | 21 | 47 | 98 |
| Dwellings—Urban | 33 | 21 | 19 | 19 | 59 |
| Industrial occupancies | 11 | 13 | 5 | 0 | 18 |
| Institutions | 3 | 0 | 12 | 1 | 13 |
| Mercantile occupancies | 10 | 9 | 1 | 0 | 10 |
| Miscellaneous buildings | 5 | 8 | 2 | 0 | 10 |
| Outside of buildings | 10 | 8 | 2 | 5 | 15 |
| Response to alarms | 7 | 8 | 0 | 0 | 8 |
| Ships and boats | 3 | 4 | 0 | 0 | 4 |
| Occupancy unknown | 5 | 6 | 0 | 0 | 6 |
| Total | 195 | 156 | 74 | 83 | 313 |

*This table is made up from those reports received by the Department of Fire Record between January 1 and March 31, 1933. A few of the fires included herein occurred prior to January 1, but were not reported until subsequent to that date.

## Typical Loss of Life Fires.

### Gasoline Vapor Explosions.

S-63126. PROVIDENCE, R. I., FEBRUARY 3, 1933. Two men were killed and two were seriously injured in an explosion which demolished the building in which they were working at a rubber factory. The explosion was due to ignition of naphtha vapors by electric or friction spark. The intense heat from blazing naphtha tanks prevented the rescue of the two men trapped in the débris.

H-36217. SAN PEDRO, CALIF., MARCH 4, 1933. One man was killed and another was severely burned in a gasoline explosion which destroyed a fifty-foot tugboat. The four gasoline tanks on the craft, having a total capacity of 2000 gallons, were under the deck housing and had no outside vents. Filling was accomplished by means of a hose through an open hatch and displaced vapors accumulated in the hold and engine room. After all the tanks had been filled and sealed, the engineer proceeded to fill eight 55-gallon steel drums, also below decks. While so engaged a flash occurred from an undetermined cause and the ship was blown to pieces.

### Gasoline Used to Start Fire.

L-1886. BARSTOW, TEXAS, JANUARY 3, 1933. Five persons were burned to death following an explosion which occurred when gasoline was used to quicken a wood fire in a stove. A man and his four children lost their lives. His wife and two other relatives were severely burned.

### Gas Explosion.

L-1887. NEWTON, MASS., FEBRUARY 16, 1933. A young woman lost her life in an explosion of illuminating gas which completely demolished the house in which she was sleeping. The gas escaped through a leak in a ten-inch main under the sidewalk in front of the house and entered the basement around the piping. Ignition from the furnace fire occurred and a terrific explosion resulted. The walls were blown out and the victim was trapped beneath the wreckage of the roof. The débris caught fire and the young woman perished before the firemen could extinguish the flames and extricate her. Her parents were blown from the building by the explosion and escaped with minor injuries.

### Trapped in Burning Building.

H-36301. BIG RAPIDS, MICH., DECEMBER 28, 1932. Three women inmates of the county farm were trapped and burned to death in a night fire. The fire started in the boiler room and spread rapidly through the old brick-joisted building, which had no fire alarm or fire protection equipment other than a few chemical extinguishers. Employees thought that they had aided all of the inmates to escape, but a check revealed that three occupants of the main dormitory were missing. By that time it was impossible to enter the building.

H-36302. VALLEJO, CALIF., JANUARY 1, 1933. Five men were trapped and burned to death in their rooms when an early morning fire swept a large frame clubhouse. The fire occurred following a New Year's party and had assumed great headway before being discovered by an outsider. The entire building was in flames when firemen arrived. They rescued several men, but the five victims sleeping in quarters on the upper floors could not be saved.

H-36003. WICKLIFFE, OHIO, FEBRUARY 3, 1933. Nine women patients were burned to death when fire destroyed a cottage in which they were housed at a sanitarium for insane persons. After being led into the cold night air the scantily clad inmates broke away from nurses and rushed back into the burning building. It was only with considerable difficulty that other patients were prevented from returning to the building.

H-36004. HULL, P. Q., MARCH 15, 1933. At least five women employees lost their lives and twenty-three other workers were injured when they were trapped in a blazing match factory. The fire started when a box of matches was dropped and flashed rapidly through the flammable stock in the building, cutting off the workers' escape. Newspapers report that two exit doors were locked. The windows had small panes of glass in metal sash, making escape through them difficult. Several of the victims who rushed into the stock room to escape the flames were trapped because there was no outside exit from that room.

# Annual Sprinkler Tables.

## Statistics of Fires in Properties Having Automatic Sprinkler Protection.

**NOTE.—These tabulations are made at the close of each year with the object of furnishing a basis upon which the virtues of the automatic sprinkler as an extinguishing agent can be estimated.**

**Section I is devoted to fires in which the behavior of sprinklers was, for the reasons given, unsatisfactory.**

**Section II is a statistical record of all reports of sprinkler fires in the files of the Association upon which the information obtained is sufficiently complete for statistical purposes.**

**In each table the results of the current year ending February 1, 1933, are given and these are compared with the results of the total thirty-seven year record ending at that time.**

The annual sprinkler tabulation is published this year for the thirty-seventh consecutive year. The tables which follow show the actual fire experience with automatic sprinkler equipments in sixty-three thousand fires. This is not intended as a complete statistical report of fires in sprinklered properties; it includes only those fires reported to the N.F.P.A. Department of Fire Record in sufficient detail to give the data necessary for the tables. While the fires included in this tabulation are probably only a fraction of the total number of fires occurring in buildings under sprinkler protection, with a total of 63,000 fires in the record and current reports being received at an average rate of three thousand annually, there can be no doubt that this summary as a whole is completely representative.

An exception to this statement may be made in the case of the detailed records of experience in some occupancies where only a comparatively small number of fires are reported. In order to maintain the continuity of the tables from year to year it is necessary to have every occupancy classification appear, even though there be but one sprinklered fire reported. It is obvious, however, that conclusions should not be drawn as to the effectiveness of sprinklers in an occupancy where the number of fires reported is so small that the figures may be distorted by some one unusual fire.

The classifications "extinguished fire" and "held fire in check" appearing in the several tables may both be considered as satisfactory performance. The distinction between these two classifications is necessarily more or less arbitrary, depending upon the judgment of the original inspector. The great majority of the fires in the "held in check" columns are instances where hose streams or other equipment were used to extinguish fire in spaces which water from the sprinklers did not reach because of obstructions to distribution, concealed spaces or unsprinklered portions, but where sprinklers functioned satisfactorily in preventing the spread of fire.

In preparing these tables it is the fixed policy of the Department of Fire Record never to give the sprinklers the benefit of the doubt. In cases where there is question as to whether a given fire should be classified as "Held in Check" or "Unsatisfactory," it is always placed in the "Unsatisfactory" column. The tables thus give a very conservative picture of the efficiency of sprinklers. Likewise it should be noted that there are doubtless a large number of fires annually which are extinguished by one or two sprinkler heads where no claim for loss is made and where no report reaches the Department of Fire Record. If it were possible to include all such fires in the tables the sprinkler efficiency would approach much nearer to one hundred per cent.

The tables presented this year follow the same general plan and arrangement as in previous years. The following changes in occupancy classification have been made during the past year:

Auto Sales and Service (fires formerly classed as Garages and Miscellaneous Mercantiles)

Dry Goods Stores (Adjustments made by addition of fires from Miscellaneous Mercantiles to correct classifications)

Garages (decreased by fires reclassed as Auto Sales and Service)

Leather Working (formerly Harness and Fancy Leather)

Miscellaneous Mercantiles (decreased by fires reclassified as Auto Sales and Service, Dry Good Stores)

Tanneries A (includes sole leather and belting formerly under Tanneries)

Tanneries B (includes upper leather formerly under Tanneries and Morocco)

Tanneries C (formerly Patent Leather)

Tanneries D (glove leather, formerly Skin Mills)

The total number of sprinklered fire reports received during the past year was 3000. This total includes 582 fires in which the sprinklers were not a factor. This latter classification includes fires occurring in unsprinklered portions of buildings which did not extend to the sprinklered portions, or fires occurring in sprinklered portions which were discovered and extinguished by other means before there was sufficient heat to open sprinklers. The total number of fires since 1897 in sprinklered properties where sprinklers were not a factor is 12,029.

The present tables include eleven fires in properties protected by thermostatically operated open head systems. These are separately listed in Section II, Tables 2 and 3.

## SECTION I.

### Summary of Unsatisfactory Sprinkler Fires.

| | 1932-1933 No. of Fires | 1932-1933 Per Cent | 1897-1933 incl. No. of Fires | 1897-1933 incl. Per Cent |
|---|---|---|---|---|
| Water shut off | 36 | 33.7 | 672 | 31.9 |
| Generally defective equipment | 4 | 3.7 | 386 | 18.4 |
| Unsprinklered portions | 7 | 6.5 | | |
| Defective water supply or supplies | 8 | 7.5 | 186 | 8.8 |
| Sprinkler system crippled due to freezing | 4 | 3.7 | 54 | 2.6 |
| Slow operation of dry system or defective valve | 6 | 5.6 | 65 | 3.1 |
| Slow or defective operation of high test heads | .. | .. | 25 | 1.2 |
| Faulty building construction, concealed spaces, vertical openings, etc. | 8 | 7.5 | 108 | 5.1 |
| Obstruction to distribution | 14 | 13.1 | 126 | 6.0 |
| Hazard of occupancy too severe for average sprinkler equipment | 2 | 1.9 | 124 | 5.9 |
| Explosion crippled sprinkler system | 9 | 8.4 | 100 | 4.8 |
| Exposure or conflagration | 1 | .9 | 84 | 4.0 |
| Plugged heads and piping (included with Miscellaneous prior to 1921) | 5 | 4.7 | 37 | 1.8 |
| Miscellaneous | 3 | 2.8 | 135 | 6.4 |
| Total | 107 | 100.0 | 2102 | 100.0 |

### Fires in Which Failure Was Due to Water Shut Off Sprinklers.

| | 1932-1933 No. of Fires | 1897-1932 No. of Fires |
|---|---|---|
| Water shut off for unknown reason, neglect or carelessness | 6 | 204 |
| Water shut off before fire was out or fire rekindled | 5 | 118 |
| Water shut off due to accidents or repairs | 3 | 105 |
| Water shut off to prevent freezing | 8 | 153 |
| Water shut off, probably incendiary | 10 | 25 |
| Water shut off, leaky dry system | .. | 15 |
| Water shut off, defective gate valve | .. | 9 |
| Water shut off, miscellaneous | 4 | 43 |
| Total | 36 | 672 |

## SECTION II.

### Annual Revision of Sprinkler Fire Tables.

The following tables are a summary of fires occurring in properties equipped with automatic sprinklers. The total number of such fires reported during the past year was 3000, which includes 582 fires where no sprinklers were opened. A number of reports were received in which the data were incomplete and these are not included in this tabulation. It may be noted that the total number of fires does not agree throughout all the tables. This is because some of the reports of fires in prior years were not sufficiently complete to include in all the tables.

## Table No. 1—Effect of Sprinklers.

| | 1932-1933 No. of Fires | % | 1897-1933 incl. No. of Fires | % |
|---|---|---|---|---|
| Practically or entirely extinguished... | 1876 | 77.4 | 35239 | 69.2 |
| Held fire in check..... | 436 | 18.1 | 13630 | 26.7 |
| Total Satisfactory..... | 2312 | 95.5 | 48869 | 95.9 |
| Unsatisfactory ..... | 107 | 4.5 | 2102 | 4.1 |
| Total..... | 2419 | | 50971 | |

## Table No. 2—Number of Sprinklers Operating.

No. of Fires, 1897-1933, inclusive

| No. of Sprinklers Operating | Wet | % | Dry | % | No Data | Total | % |
|---|---|---|---|---|---|---|---|
| 1 .....15153 | | 38.2 | 1699 | 19.6 | 569 | 17421 | 34.3 |
| 2 or less.....22516 | | 56.7 | 2877 | 33.8 | 850 | 26243 | 49.8 |
| 3 or less.....26475 | | 66.8 | 3622 | 42.5 | 1019 | 31116 | 61.3 |
| 4 or less.....29209 | | 73.5 | 4240 | 49.8 | 1156 | 34605 | 68.3 |
| 5 or less.....30847 | | 77.8 | 4634 | 54.4 | 1246 | 36727 | 72.5 |
| 6 or less.....32159 | | 81.0 | 5012 | 58.9 | 1318 | 38489 | 76.0 |
| 7 or less.....33074 | | 83.3 | 5293 | 62.2 | 1361 | 39728 | 78.4 |
| 8 or less.....33924 | | 85.5 | 5532 | 65.1 | 1410 | 40866 | 80.8 |
| 9 or less.....34495 | | 86.9 | 5724 | 67.2 | 1444 | 41663 | 82.3 |
| 10 or less.....35004 | | 88.2 | 5889 | 69.4 | 1487 | 42480 | 83.8 |
| 11 or less.....35382 | | 89.1 | 6030 | 70.9 | 1505 | 42917 | 84.7 |
| 12 or less.....35789 | | 90.2 | 6213 | 62.9 | 1544 | 43546 | 85.9 |
| 13 or less.....36036 | | 90.7 | 6346 | 74.4 | 1561 | 43943 | 86.7 |
| 14 or less.....36320 | | 91.4 | 6463 | 76.0 | 1580 | 44363 | 87.4 |
| 15 or less.....36551 | | 92.0 | 6578 | 77.3 | 1595 | 44724 | 88.3 |
| 20 or less.....37362 | | 93.9 | 6941 | 81.6 | 1662 | 45965 | 90.8 |
| 25 or less.....37836 | | 95.2 | 7209 | 84.8 | 1693 | 46738 | 92.3 |
| 30 or less.....38166 | | 96.1 | 7392 | 86.9 | 1715 | 47273 | 93.4 |
| 35 or less.....38365 | | 96.6 | 7515 | 88.2 | 1730 | 47610 | 94.1 |
| 40 or less.....38546 | | 97.0 | 7619 | 89.6 | 1746 | 47911 | 94.6 |
| 50 or less.....38765 | | 97.4 | 7764 | 91.3 | 1765 | 48295 | 95.4 |
| 75 or less.....39076 | | 98.4 | 7963 | 93.6 | 1784 | 48823 | 96.3 |
| 100 or less.....39214 | | 98.8 | 8066 | 94.9 | 1793 | 49073 | 97.0 |
| Over 100..... 423 | | | 346 | | 37 | 806 | |
| No data..... 94 | | | 84 | | 592 | 770 | |
| Open head systems .. | | | 11 | | .. | 11 | |
| Total.....39731 | | | 8507 | | 2422 | 50660 | |
| Water shut off sprinklers..... | | | | | | 311 | |
| Total..... | | | | | | 50971 | |

## Table No. 3—Numbers of Sprinklers Operating.

No. of Fires, 1932-1933

| No. of Sprinklers Operating | Wet | % | Dry | % | No Data | Total | % |
|---|---|---|---|---|---|---|---|
| 1 | 776 | 42.7 | 97 | 20.7 | 21 | 894 | 37.0 |
| 2 | 363 | 20.0 | 74 | 15.8 | 9 | 446 | 18.5 |
| 3 | 171 | 9.4 | 42 | 9.0 | 11 | 224 | 9.3 |
| 4 | 115 | 6.4 | 45 | 9.6 | 7 | 167 | 6.9 |
| 5 | 73 | 4.0 | 19 | 4.0 | 6 | 98 | 4.1 |
| 6 | 51 | 2.8 | 25 | 5.3 | 5 | 81 | 3.4 |
| 7 | 37 | 2.0 | 13 | 2.8 | 1 | 51 | 2.1 |
| 8 | 29 | 1.6 | 16 | 3.4 | 0 | 45 | 1.6 |
| 9 | 17 | .9 | 7 | 1.5 | 1 | 25 | 1.0 |
| 10 | 15 | .8 | 3 | .6 | 0 | 18 | .8 |
| 11 | 15 | .8 | 5 | 1.1 | 1 | 21 | .9 |
| 12 | 15 | .8 | 10 | 2.1 | 2 | 27 | 1.1 |
| 13 | 12 | .7 | 8 | 1.7 | 0 | 20 | .8 |
| 14 | 11 | .6 | 6 | 1.3 | 2 | 19 | .8 |
| 15 | 6 | .3 | 4 | .8 | 0 | 10 | .4 |
| 16-20 | 37 | 2.0 | 22 | 4.7 | 5 | 64 | 2.7 |
| 21-25 | 11 | .6 | 17 | 3.6 | 3 | 31 | 1.3 |
| 26-30 | 12 | .7 | 7 | 1.5 | 1 | 20 | .8 |
| 31-35 | 8 | .4 | 5 | 1.1 | 2 | 15 | .6 |
| 36-40 | 9 | .5 | .. | .. | .. | 9 | .4 |
| 41-50 | 7 | .4 | 7 | 1.5 | 3 | 17 | .7 |
| 51-75 | 15 | .8 | 11 | 2.3 | 1 | 27 | 1.1 |
| 76-100 | 3 | .2 | 2 | .4 | .. | 5 | .2 |
| Over 100 | 7 | .4 | 12 | 2.8 | 2 | 21 | .9 |
| No Data | 3 | .2 | 6 | 1.3 | 49 | 58 | 2.4 |
| Open head systems | 0 | .. | 5 | 1.1 | .. | 5 | .2 |
| Total | 1818 | 100.0 | 468 | 100.0 | 132 | 2418 | 100.0 |

No. of Fires, 1897-1933, inclusive

| No. of Sprinklers Operating | Wet | % | Dry | % | No Data | Total | % |
|---|---|---|---|---|---|---|---|
| 1 | 15153 | 38.2 | 1699 | 19.6 | 569 | 17421 | 34.3 |
| 2 | 7363 | 18.5 | 1178 | 13.8 | 281 | 8822 | 17.4 |
| 3 | 3959 | 10.0 | 745 | 8.8 | 169 | 4873 | 9.6 |
| 4 | 2734 | 6.9 | 618 | 7.3 | 137 | 3489 | 6.9 |
| 5 | 1638 | 4.1 | 394 | 4.6 | 90 | 2122 | 4.2 |
| 6 | 1312 | 3.3 | 378 | 4.5 | 72 | 1762 | 3.5 |
| 7 | 915 | 2.3 | 281 | 3.3 | 43 | 1239 | 2.4 |
| 8 | 850 | 2.1 | 239 | 2.8 | 49 | 1138 | 2.2 |
| 9 | 571 | 1.4 | 192 | 2.3 | 34 | 797 | 1.6 |
| 10 | 509 | 1.3 | 165 | 2.0 | 43 | 717 | 1.4 |
| 11 | 378 | 1.0 | 141 | 1.7 | 18 | 537 | 1.1 |
| 12 | 407 | 1.0 | 183 | 2.2 | 39 | 629 | 1.2 |
| 13 | 247 | .6 | 133 | 1.6 | 17 | 397 | .8 |
| 14 | 284 | .7 | 117 | 1.4 | 19 | 420 | .8 |
| 15 | 231 | .6 | 115 | 1.4 | 15 | 361 | .7 |
| 16-20 | 811 | 2.0 | 363 | 4.3 | 67 | 1241 | 2.5 |
| 21-25 | 474 | 1.2 | 268 | 3.2 | 31 | 773 | 1.6 |
| 26-30 | 330 | .8 | 183 | 2.2 | 22 | 535 | 1.1 |
| 31-35 | 199 | .5 | 123 | 1.4 | 15 | 337 | .7 |
| 36-40 | 181 | .5 | 104 | 1.2 | 16 | 301 | .6 |
| 41-50 | 219 | .6 | 145 | 1.7 | 20 | 384 | .8 |
| 51-75 | 311 | .8 | 199 | 2.3 | 18 | 528 | 1.0 |
| 76-100 | 138 | .3 | 103 | 1.2 | 9 | 250 | .5 |
| Over 100 | 423 | 1.1 | 346 | 4.1 | 37 | 806 | 1.6 |
| No data | 94 | .2 | 84 | 1.0 | 592 | 770 | 1.5 |
| Open head systems | 0 | .. | 11 | .1 | 0 | 11 | .. |
| Total | 39731 | 100.0 | 8507 | 100.0 | 2422 | 50660 | 100.0 |
| Water shut off sprinklers | | | | | | 311 | |
| Total | | | | | | 50971 | |

## Table No. 4—Effect of Sprinklers by Class of Occupancy.

| | Extinguished Fire | | Held Fire in Check | | Total Satisfactory | | Unsatisfactory | | Total No. of Fires |
|---|---|---|---|---|---|---|---|---|---|
| | No. | % | No. | % | No. | % | No. | % | |
| Abrasive Works | 26 | 74.4 | 7 | 20.0 | 33 | 94.4 | 2 | 5.6 | 35 |
| Agricultural Implements | 75 | 60.0 | 44 | 35.2 | 119 | 95.2 | 6 | 4.8 | 125 |
| Airplane Factories | 8 | 53.3 | 7 | 46.7 | 15 | 100.0 | .. | .. | 15 |
| Airports and Hangars | 1 | 20.0 | 4 | 80.0 | 5 | 100.0 | .. | .. | 5 |
| Alcohol Distilleries | 6 | 50.0 | 3 | 25.0 | 9 | 75.0 | 3 | 25.0 | 12 |
| Aluminum Works | 5 | 55.6 | 3 | 33.3 | 8 | 88.9 | 1 | 11.1 | 9 |
| Amusement Places | 26 | 81.2 | 3 | 9.4 | 29 | 90.6 | 3 | 9.4 | 32 |
| Apartment Houses | 130 | 85.5 | 22 | 14.5 | 152 | 100.0 | .. | .. | 152 |
| Artificial Leather Mfg. | 30 | 50.9 | 26 | 44.1 | 56 | 95.0 | 3 | 5.0 | 59 |
| Asbestos Works | 21 | 53.9 | 15 | 38.5 | 36 | 92.4 | 3 | 7.6 | 39 |
| Automobile and Bicycle Mfg. | 314 | 65.3 | 146 | 30.3 | 460 | 95.6 | 21 | 4.4 | 481 |
| Auto and Carriage Body Mfg. | 155 | 58.7 | 84 | 31.8 | 239 | 90.5 | 25 | 9.5 | 264 |
| Automobile Paint Shops | 10 | 77.0 | 3 | 23.0 | 13 | 100.0 | .. | .. | 13 |
| Auto Sales and Service | 33 | 71.8 | 8 | 17.4 | 41 | 89.2 | 5 | 10.8 | 46 |
| Bag Factories | 49 | 66.3 | 22 | 29.7 | 71 | 96.0 | 3 | 4.0 | 74 |
| Bakeries | 175 | 75.2 | 50 | 21.4 | 225 | 96.6 | 8 | 3.4 | 233 |
| Basket Factories | 12 | 80.0 | 2 | 13.3 | 14 | 93.3 | 1 | 6.7 | 15 |
| Battery Mfg. | 41 | 70.7 | 14 | 25.2 | 55 | 95.9 | 3 | 4.1 | 58 |
| Bolt, Nut and Screw Works | 23 | 57.5 | 14 | 35.0 | 37 | 92.5 | 3 | 7.5 | 40 |
| Bottle Caps and Seals Mfg. | 42 | 53.9 | 36 | 46.1 | 78 | 100.0 | .. | .. | 78 |
| Bottling Works | 8 | 72.7 | 2 | 18.2 | 10 | 90.9 | 1 | 9.1 | 11 |
| Braid Mills | 64 | 77.1 | 17 | 20.5 | 81 | 97.6 | 2 | 2.4 | 83 |
| Brass and Copper Works | 84 | 73.0 | 28 | 24.4 | 112 | 97.4 | 3 | 2.6 | 115 |
| Breweries | 5 | 83.3 | 1 | 16.7 | 6 | 100.0 | .. | .. | 6 |
| Brick and Tile Works | 1 | 100.0 | .. | 100.0 | 1 | .. | .. | .. | 1 |
| Broom Factories | 21 | 67.7 | 8 | 25.8 | 29 | 93.5 | 2 | 6.5 | 31 |
| Brush Factories | 33 | 71.7 | 13 | 28.3 | 46 | 100.0 | .. | .. | 46 |
| Buildings Under Construction | 5 | 62.5 | 3 | 37.5 | 8 | 100.0 | .. | .. | 8 |
| Button Factories | 77 | 83.8 | 13 | 14.3 | 90 | 98.1 | 2 | 1.9 | 92 |
| Candle Factories | 9 | 56.3 | 7 | 43.7 | 16 | 100.0 | .. | .. | 16 |
| Candy Factories | 231 | 72.4 | 77 | 24.1 | 308 | 96.5 | 11 | 3.5 | 319 |
| Canneries | 21 | 66.6 | 8 | 25.0 | 29 | 91.6 | 3 | 8.4 | 32 |
| Canvas and Cotton Belting | 6 | 66.7 | 3 | 33.3 | 9 | 100.0 | .. | .. | 9 |
| Carbon Works | 8 | 88.9 | 1 | 11.1 | 9 | 100.0 | .. | .. | 9 |
| Car Houses | 42 | 46.1 | 41 | 45.0 | 83 | 91.1 | 8 | 8.9 | 91 |
| Car Works | 83 | 61.5 | 47 | 34.8 | 130 | 96.3 | 5 | 3.7 | 135 |
| Carpet and Rug Mills | 204 | 64.2 | 103 | 32.4 | 307 | 96.6 | 11 | 3.4 | 318 |
| Cement and Plaster Mills | 11 | 61.1 | 4 | 22.2 | 15 | 83.3 | 3 | 16.7 | 18 |
| Cereal Mills | 41 | 64.1 | 15 | 23.4 | 56 | 87.5 | 8 | 12.5 | 64 |
| Chemical and White Lead Works | 197 | 62.5 | 96 | 30.5 | 293 | 93.0 | 22 | 7.0 | 315 |
| Clock and Watch Mfg. | 16 | 84.2 | 3 | 15.8 | 19 | 100.0 | .. | .. | 19 |
| Clothing Mfg. | 2257 | 85.7 | 349 | 13.3 | 2606 | 99.0 | 20 | 1.0 | 2626 |
| Clubs—City | 26 | 83.9 | 4 | 12.9 | 30 | 96.8 | 1 | 3.2 | 31 |
| Clubs—Country | 9 | 60.0 | 6 | 40.0 | 15 | 100.0 | .. | .. | 15 |
| Coal and Wood Yards | 3 | 37.5 | 5 | 62.5 | 8 | 100.0 | .. | .. | 8 |
| Cocoanut Mills | 5 | 71.5 | 2 | 28.5 | 7 | 100.0 | .. | .. | 7 |
| Coffee and Spice Mills | 90 | 70.8 | 33 | 25.0 | 123 | 95.8 | 4 | 4.2 | 127 |
| Coffin and Casket Mfg. | 80 | 75.5 | 21 | 19.8 | 101 | 95.3 | 5 | 4.7 | 106 |
| Cold Storage Plants | 14 | 63.7 | 8 | 36.3 | 22 | 100.0 | .. | .. | 22 |
| Cooperage Plants | 63 | 60.6 | 29 | 28.9 | 92 | 89.5 | 12 | 10.5 | 104 |
| Cordage Works | 251 | 65.5 | 118 | 30.8 | 369 | 96.3 | 14 | 3.7 | 383 |
| Cork Factories | 28 | 50.9 | 22 | 40.0 | 50 | 90.9 | 5 | 9.1 | 55 |
| Cotton Gins | 11 | 64.8 | 5 | 29.4 | 16 | 94.2 | 1 | 5.8 | 17 |
| Cotton Mills | 5933 | 65.0 | 3088 | 33.9 | 9021 | 98.9 | 114 | 1.1 | 9135 |
| Cotton Seed Oil Mills | 44 | 46.4 | 31 | 32.6 | 75 | 79.0 | 17 | 21.0 | 92 |
| Cotton Warehouses | 227 | 49.6 | 192 | 41.9 | 419 | 91.5 | 40 | 8.5 | 459 |
| Cutlery Mfg. | 29 | 59.2 | 17 | 34.7 | 46 | 93.9 | 3 | 6.1 | 49 |
| Dairies and Creameries | 7 | 77.9 | 2 | 22.1 | 9 | 100.0 | .. | .. | 9 |
| Department Stores | 712 | 79.5 | 162 | 18.1 | 874 | 97.6 | 21 | 2.4 | 895 |

| | Extinguished Fire | | Held Fire in Check | | Total Satisfactory | | Unsatisfactory | | Total No. of Fires |
|---|---|---|---|---|---|---|---|---|---|
| | No. | % | No. | % | No. | % | No. | % | |
| Distilleries | 4 | 57.2 | 3 | 42.8 | 7 | 100.0 | .. | .. | 7 |
| Doll Factories | 76 | 63.3 | 44 | 36.7 | 120 | 100.0 | .. | .. | 120 |
| Drug Mfg. and Warehouses | 251 | 80.3 | 57 | 18.2 | 308 | 98.5 | 6 | 1.5 | 314 |
| Dry Cleaning Establishments | 17 | 60.8 | 11 | 39.2 | 28 | 100.0 | .. | .. | 28 |
| Dry Goods Stores | 377 | 85.9 | 57 | 13.0 | 434 | 98.9 | 5 | 1.1 | 439 |
| Dwellings | .. | .. | .. | .. | .. | .. | 1 | 100.0 | 1 |
| Dyeing, Bleaching, Finishing | 279 | 58.6 | 179 | 37.6 | 458 | 96.2 | 18 | 3.8 | 476 |
| Electrical Appliance Mfg. | 502 | 71.9 | 185 | 26.4 | 687 | 98.3 | 13 | 1.7 | 700 |
| Electric Power and Light | 8 | 42.1 | 8 | 42.1 | 16 | 84.2 | 3 | 15.8 | 19 |
| Excelsior Factories | 34 | 68.0 | 12 | 24.0 | 46 | 92.0 | 4 | 8.0 | 50 |
| Fertilizer Plants | 30 | 63.9 | 13 | 27.7 | 43 | 91.6 | 4 | 8.4 | 47 |
| Fiber Products | 13 | 56.6 | 9 | 39.1 | 22 | 95.7 | 1 | 4.3 | 23 |
| Fireworks Plants | .. | .. | 2 | 100.0 | 2 | 100.0 | .. | .. | 2 |
| Flax and Linen Mills | 49 | 57.7 | 36 | 42.3 | 85 | 100.0 | .. | .. | 85 |
| Flour and Grist Mills | 84 | 52.8 | 47 | 29.6 | 131 | 82.4 | 28 | 17.6 | 159 |
| Forge and Smithy | 28 | 70.0 | 10 | 25.0 | 38 | 95.0 | 2 | 5.0 | 40 |
| Foundries | 240 | 61.2 | 135 | 34.4 | 375 | 95.6 | 18 | 4.4 | 393 |
| Fruit Packing | 6 | 100.0 | .. | .. | 6 | 100.0 | .. | .. | 6 |
| Fur Works | 206 | 94.2 | 9 | 4.1 | 215 | 98.3 | 4 | 1.7 | 219 |
| Furniture Factories | 998 | 68.5 | 369 | 25.3 | 1367 | 93.8 | 102 | 6.2 | 1469 |
| Furniture Stores | 132 | 79.5 | 27 | 16.3 | 159 | 95.8 | 7 | 4.2 | 166 |
| Garages | 556 | 70.5 | 214 | 27.2 | 770 | 97.7 | 19 | 2.3 | 789 |
| Garbage Reduction Plants | 3 | 60.0 | 1 | 20.0 | 4 | 80.0 | 1 | 20.0 | 5 |
| Gas Works | 3 | 50.0 | 2 | 33.4 | 5 | 83.4 | 1 | 16.6 | 6 |
| General Stores | 1 | 50.0 | 1 | 50.0 | 2 | 100.0 | .. | .. | 2 |
| Glass Factories | 99 | 60.0 | 49 | 29.7 | 148 | 89.7 | 17 | 10.3 | 165 |
| Glove Factories | 20 | 71.4 | 7 | 25.0 | 27 | 96.4 | 1 | 3.6 | 28 |
| Glue Factories | 10 | 45.4 | 9 | 40.8 | 19 | 86.2 | 3 | 13.8 | 22 |
| Grain Elevators | 38 | 40.0 | 31 | 32.6 | 69 | 72.6 | 26 | 27.4 | 95 |
| Groceries | 200 | 78.4 | 45 | 17.6 | 245 | 96.0 | 10 | 4.0 | 255 |
| Gum Mfg. | 8 | 89.0 | 1 | 11.0 | 9 | 100.0 | .. | .. | 9 |
| Hair Works | 25 | 78.1 | 7 | 21.9 | 32 | 100.0 | .. | .. | 32 |
| Hardware Stores | 126 | 82.4 | 24 | 16.0 | 150 | 98.4 | 3 | 1.6 | 153 |
| Hat Factories | 425 | 79.6 | 89 | 16.7 | 514 | 96.3 | 20 | 3.7 | 534 |
| Hotels—Year Round | 91 | 81.2 | 17 | 15.1 | 108 | 96.3 | 4 | 3.7 | 112 |
| Hotels—Seasonal | 9 | 56.2 | 6 | 37.5 | 15 | 93.7 | 1 | 6.3 | 16 |
| Ice Cream Mfg. | 7 | 58.3 | 5 | 41.7 | 12 | 100.0 | .. | .. | 12 |
| Ice Houses | .. | .. | 2 | 66.7 | 2 | 66.7 | 1 | 33.3 | 3 |
| Ice Manufacturing | 2 | 66.7 | 1 | 33.3 | 3 | 100.0 | .. | .. | 3 |
| Idle and Vacant Property | 43 | 56.6 | 13 | 17.1 | 56 | 73.7 | 20 | 16.3 | 76 |
| Incandescent Lamp Works | 26 | 66.6 | 13 | 33.4 | 39 | 100.0 | .. | .. | 39 |
| Institutions | 40 | 85.1 | 7 | 14.9 | 47 | 100.0 | .. | .. | 47 |
| Insulated Wire Works | 58 | 65.2 | 29 | 31.4 | 87 | 96.6 | 2 | 3.4 | 89 |
| Jewelry Factories | 201 | 85.2 | 28 | 11.8 | 229 | 97.0 | 7 | 3.0 | 236 |
| Junk Shops | 27 | 72.9 | 8 | 21.6 | 35 | 94.5 | 2 | 5.5 | 37 |
| Knitting Mills—Cop Yarn | 69 | 67.6 | 26 | 25.5 | 95 | 93.1 | 7 | 6.9 | 102 |
| Knitting Mills—Full Process | 639 | 67.9 | 273 | 29.0 | 912 | 96.9 | 29 | 3.1 | 941 |
| Lamp Shade Factories | 44 | 91.7 | 3 | 6.2 | 47 | 97.9 | 1 | 2.1 | 48 |
| Laundries | 150 | 73.5 | 48 | 23.5 | 198 | 97.0 | 6 | 3.0 | 204 |
| Lead Pencil Factories | 18 | 69.2 | 7 | 26.9 | 25 | 96.1 | 1 | 3.9 | 26 |
| Leather Working | 216 | 82.1 | 42 | 16.0 | 258 | 98.1 | 5 | 1.9 | 263 |
| Linoleum Works | 34 | 28.6 | 67 | 56.3 | 101 | 84.9 | 18 | 15.1 | 119 |
| Linseed Oil Works | 24 | 52.1 | 14 | 30.4 | 38 | 82.5 | 8 | 17.5 | 46 |
| Lumber Yards | 11 | 78.6 | 3 | 21.4 | 14 | 100.0 | .. | .. | 14 |
| Macaroni Factories | 11 | 68.7 | 3 | 18.7 | 14 | 87.4 | 2 | 12.6 | 16 |
| Machine Shops and Works | 456 | 71.2 | 154 | 24.1 | 610 | 95.3 | 30 | 4.7 | 640 |
| Mail Order Houses | 58 | 87.8 | 8 | 12.2 | 66 | 100.0 | .. | .. | 66 |
| Match Factories | 70 | 76.0 | 17 | 18.5 | 87 | 94.5 | 5 | 5.5 | 92 |
| Mattress Factories | 603 | 69.8 | 244 | 28.2 | 847 | 98.0 | 17 | 2.0 | 864 |
| Mercantile (Miscellaneous) | 1057 | 82.5 | 193 | 15.1 | 1250 | 97.6 | 30 | 3.9 | 1280 |

| | Extinguished Fire | | Held Fire in Check | | Total Satisfactory | | Unsatisfactory | | Total No. of Fires |
|---|---|---|---|---|---|---|---|---|---|
| | No. | % | No. | % | No. | % | No. | % | |
| Metal Reduction Plants | 11 | 68.7 | 5 | 31.3 | 16 | 100.0 | .. | .. | 16 |
| Metal Workers† | 1247 | 64.3 | 611 | 31.5 | 1858 | 95.8 | 81 | 4.2 | 1939 |
| Mining Property | 2 | 40.0 | 2 | 40.0 | 4 | 80.0 | 1 | 20.0 | 5 |
| Mirror Mfg. | 21 | 91.3 | 2 | 8.7 | 23 | 100.0 | .. | .. | 23 |
| Miscellaneous | 459 | 76.0 | 118 | 19.5 | 577 | 95.5 | 27 | 4.5 | 604 |
| Motion Picture Exchanges | 52 | 74.6 | 12 | 17.6 | 64 | 92.2 | 3 | 7.8 | 67 |
| Motion Picture Studios | 35 | 76.1 | 11 | 23.9 | 46 | 100.0 | .. | .. | 46 |
| Motion Picture Theatres | 78 | 81.2 | 12 | 12.5 | 90 | 93.7 | 6 | 6.3 | 96 |
| Multiple Occupancy | 78 | 72.9 | 17 | 15.9 | 95 | 88.8 | 12 | 11.2 | 107 |
| Munition Plants | 25 | 43.8 | 23 | 40.3 | 48 | 84.1 | 9 | 15.9 | 57 |
| Musical Instruments Factories | 160 | 70.2 | 61 | 26.8 | 221 | 97.0 | 7 | 3.0 | 228 |
| Office Buildings | 97 | 87.4 | 14 | 12.6 | 111 | 100.0 | .. | .. | 111 |
| Oil Cloth Works | 30 | 48.4 | 25 | 40.3 | 55 | 88.7 | 7 | 11.3 | 62 |
| Oil Clothing Factories | 20 | 74.0 | 6 | 22.2 | 26 | 96.2 | 1 | 3.8 | 27 |
| Oil Distributing Stations | 2 | 50.0 | 2 | 50.0 | 4 | 100.0 | .. | .. | 4 |
| Oil Refineries—Animal | 3 | 50.0 | 3 | 50.0 | 6 | 100.0 | .. | .. | 6 |
| Oil Refineries—Mineral | 7 | 63.6 | 4 | 36.4 | 11 | 100.0 | .. | .. | 11 |
| Oil Refineries—Vegetable | 14 | 50.0 | 10 | 35.5 | 24 | 85.5 | 4 | 14.5 | 28 |
| Optical Works | 21 | 63.6 | 12 | 36.4 | 33 | 100.0 | .. | .. | 33 |
| Packing Houses | 199 | 70.0 | 75 | 26.3 | 274 | 96.3 | 11 | 3.7 | 285 |
| Paint and Varnish Works | 302 | 65.8 | 139 | 30.3 | 441 | 96.1 | 18 | 3.9 | 459 |
| Paper Coating Mills | 32 | 71.1 | 9 | 20.0 | 41 | 91.1 | 4 | 8.9 | 45 |
| Paper Mills | 655 | 52.5 | 481 | 38.5 | 1136 | 91.0 | 112 | 9.0 | 1248 |
| Paper Working | 378 | 77.2 | 101 | 20.6 | 479 | 97.8 | 11 | 2.2 | 490 |
| Peanut Roasting Plants | 4 | 57.1 | 1 | 14.3 | 5 | 71.4 | 2 | 28.6 | 7 |
| Phonograph Works | 33 | 68.7 | 14 | 29.2 | 47 | 97.9 | 1 | 2.1 | 48 |
| Photographic Establishments | 69 | 78.4 | 18 | 20.4 | 87 | 98.8 | 1 | 1.2 | 88 |
| Picture Frame Mfg. | 60 | 65.3 | 26 | 28.3 | 86 | 94.6 | 6 | 5.4 | 92 |
| Piers and Wharves | 19 | 51.4 | 15 | 40.6 | 34 | 92.0 | 3 | 8.0 | 37 |
| Plumbers' Supplies | 41 | 73.2 | 12 | 21.4 | 53 | 94.6 | 3 | 5.4 | 56 |
| Potteries | 59 | 63.5 | 26 | 28.0 | 85 | 91.5 | 8 | 8.5 | 93 |
| Printing and Lithographing | 1143 | 82.4 | 220 | 15.9 | 1363 | 98.3 | 24 | 1.7 | 1387 |
| Prisons | 4 | 40.0 | 4 | 40.0 | 8 | 80.0 | 2 | 20.0 | 10 |
| Public Buildings | 8 | 88.9 | 1 | 11.1 | 9 | 100.0 | .. | .. | 9 |
| Pulp Mills | 49 | 38.9 | 52 | 41.3 | 101 | 80.2 | 25 | 19.8 | 126 |
| Pyroxylin Plastic Mfg. Fabricating | 247 | 68.5 | 81 | 22.4 | 328 | 90.9 | 33 | 9.1 | 361 |
| Radios and Accessories | 54 | 81.8 | 10 | 15.2 | 64 | 97.0 | 2 | 3.0 | 66 |
| Railroad—Misc. Property | 5 | 33.3 | 9 | 60.0 | 14 | 93.3 | 1 | 6.7 | 15 |
| Railroad—Repair Shops | 3 | 42.9 | 4 | 57.1 | 7 | 100.0 | .. | .. | 7 |
| Rayon Mills | 29 | 85.4 | 4 | 11.8 | 33 | 97.2 | 1 | 2.8 | 34 |
| Restaurants | 159 | 75.4 | 49 | 23.2 | 208 | 98.6 | 3 | 1.4 | 211 |
| Rice Mills | 2 | 28.6 | 1 | 14.3 | 3 | 42.9 | 4 | 57.1 | 7 |
| Rolling, Wire and Tube Mills | 84 | 66.1 | 39 | 30.5 | 123 | 96.6 | 5 | 3.4 | 128 |
| Roofing Works | 44 | 39.3 | 58 | 51.8 | 102 | 91.1 | 10 | 8.9 | 112 |
| Rooming and Lodging Houses | 8 | 88.9 | .. | .. | 8 | 88.9 | 1 | 11.1 | 9 |
| Rubber Cloth Factories | 57 | 60.7 | 33 | 35.2 | 90 | 95.9 | 4 | 4.1 | 94 |
| Rubber Reclaiming Works | 21 | 55.3 | 9 | 23.7 | 30 | 79.0 | 8 | 21.0 | 38 |
| Rubber Mills | 277 | 55.0 | 200 | 39.7 | 477 | 94.7 | 26 | 5.3 | 503 |
| Salt Works | 2 | 50.0 | 2 | 50.0 | 4 | 100.0 | .. | .. | 4 |
| Saw and Planing Mills | 117 | 42.1 | 89 | 32.0 | 206 | 74.1 | 72 | 25.9 | 278 |
| Schools—Colleges and Universities | 14 | 82.4 | 3 | 17.6 | 17 | 100.0 | .. | .. | 17 |
| Schools—Private | 4 | 66.7 | 1 | 16.7 | 5 | 83.4 | 1 | 16.6 | 6 |
| Schools—Public | 8 | 72.7 | 2 | 18.2 | 10 | 90.9 | 1 | 9.1 | 11 |
| Schools—Trade and Industrial | 13 | 81.3 | 2 | 12.5 | 15 | 93.8 | 1 | 6.2 | 16 |
| Shipyards | 13 | 52.0 | 11 | 44.0 | 24 | 96.0 | 1 | 4.0 | 25 |
| Shoddy Mills | 270 | 66.9 | 110 | 27.3 | 380 | 94.2 | 23 | 5.8 | 403 |
| Shoe Factories | 934 | 74.6 | 269 | 21.5 | 1203 | 96.1 | 48 | 3.9 | 1251 |
| Shoe Mfg. Accessories | 104 | 70.3 | 38 | 25.7 | 142 | 96.0 | 6 | 4.0 | 148 |
| Shoe Stores | 81 | 87.2 | 12 | 12.8 | 93 | 100.0 | .. | .. | 93 |
| Silk Mills | 181 | 81.2 | 34 | 15.3 | 215 | 96.5 | 8 | 3.5 | 223 |

| | Extinguished Fire | | Held Fire in Check | | Total Satisfactory | | Unsatisfactory | | Total No. of Fires |
|---|---|---|---|---|---|---|---|---|---|
| | No. | % | No. | % | No. | % | No. | % | |
| Smelting and Refining | 2 | 40.0 | 3 | 60.0 | 5 | 100.0 | .. | .. | 5 |
| Soap Manufacturing | 57 | 73.1 | 18 | 23.1 | 75 | 96.2 | 3 | 3.8 | 78 |
| Stables | 21 | 77.8 | 6 | 22.2 | 27 | 100.0 | .. | .. | 27 |
| Stamping and Sheet Metal Works | 178 | 61.4 | 94 | 32.4 | 272 | 93.8 | 18 | 6.2 | 290 |
| Starch and Glucose Works | 15 | 55.6 | 4 | 14.8 | 19 | 70.4 | 8 | 29.6 | 27 |
| Stone Working | 2 | 100.0 | .. | .. | 2 | 100.0 | .. | .. | 2 |
| Sugar Refineries | 41 | 54.7 | 31 | 41.4 | 72 | 96.1 | 3 | 3.9 | 75 |
| Tannery Class A** | 19 | 40.4 | 24 | 51.1 | 43 | 91.5 | 4 | 8.5 | 47 |
| Tannery Class B** | 121 | 55.5 | 78 | 35.8 | 199 | 91.3 | 19 | 8.7 | 218 |
| Tannery Class C** | 18 | 43.9 | 18 | 43.9 | 36 | 87.8 | 5 | 12.2 | 41 |
| Tannery Class D** | 24 | 72.8 | 8 | 24.2 | 32 | 97.0 | 1 | 3.0 | 33 |
| Tenant Manufacturing | 1599 | 78.6 | 358 | 17.6 | 1957 | 96.2 | 80 | 3.8 | 2037 |
| Theatres | 91 | 75.8 | 22 | 18.3 | 113 | 94.1 | 7 | 5.9 | 120 |
| Tobacco Factories | 98 | 76.0 | 27 | 20.9 | 125 | 96.9 | 4 | 3.1 | 129 |
| Trunk Factories | 43 | 72.9 | 9 | 15.3 | 52 | 88.2 | 7 | 11.8 | 59 |
| Umbrella Mfg. | 20 | 80.0 | 4 | 16.0 | 24 | 96.0 | 1 | 4.0 | 25 |
| Vinegar Works | 1 | 100.0 | .. | .. | 1 | 100.0 | .. | .. | 1 |
| Wall Paper Factories | 26 | 72.3 | 6 | 16.7 | 32 | 89.0 | 4 | 11.0 | 36 |
| Warehouses | 640 | 71.5 | 204 | 22.8 | 844 | 94.3 | 51 | 5.7 | 895 |
| Waste and Batting Mills | 379 | 60.8 | 215 | 34.6 | 594 | 95.4 | 29 | 4.6 | 623 |
| Waste Paper and Rag Shops | 192 | 63.8 | 95 | 31.6 | 287 | 95.4 | 14 | 4.6 | 301 |
| Water Works | .. | .. | 1 | 100.0 | 1 | 100.0 | .. | .. | 1 |
| Weaving Mills | 184 | 68.2 | 79 | 29.3 | 263 | 94.5 | 7 | 2.6 | 270 |
| Window Shade Factories | 17 | 73.9 | 4 | 17.4 | 21 | 91.3 | 2 | 8.7 | 23 |
| Woodworker, Class A* | 209 | 55.7 | 116 | 30.9 | 325 | 86.6 | 51 | 13.4 | 376 |
| Woodworker, Class B* | 197 | 52.4 | 143 | 38.1 | 340 | 90.5 | 36 | 9.5 | 376 |
| Woodworker, Class C* | 197 | 61.9 | 102 | 32.1 | 299 | 94.0 | 19 | 6.0 | 318 |
| Woodworker, Class D* | 131 | 57.8 | 73 | 32.1 | 204 | 89.9 | 23 | 10.1 | 227 |
| Woodworker, Class E* | 272 | 67.9 | 113 | 28.2 | 385 | 96.1 | 16 | 3.9 | 401 |
| Woodworker, Class F* | 46 | 60.5 | 26 | 34.2 | 72 | 94.7 | 4 | 5.3 | 76 |
| Woodworker, Class G* | 2 | 20.0 | 7 | 70.0 | 9 | 90.0 | 1 | 10.0 | 10 |
| Woolen Mills | 1163 | 69.9 | 424 | 25.6 | 1587 | 95.5 | 76 | 4.5 | 1663 |
| Wool Scouring Plants | 40 | 67.9 | 16 | 27.2 | 56 | 95.1 | 3 | 4.9 | 59 |
| Wool Storehouses | 33 | 68.7 | 12 | 25.0 | 45 | 93.7 | 3 | 6.3 | 48 |
| Worsted Mills | 95 | 59.7 | 50 | 31.5 | 145 | 91.2 | 14 | 8.8 | 159 |
| Total | 35,239 | | 13,630 | | 48,869 | | 2,102 | | 50,971 |

*The Woodworkers are classified as follows:

Class A. Interior Woodwork, builders' supplies (including veneer works).

Class B. Box Factories (including cigar boxes).

Class C. Miscellaneous Woodworkers. Steam power tenant Woodworkers. Woodworkers where there is a lack of detailed information as to class.

Class D. Sash, Door and Blind Factories.

Class E. Hard Wood Turning (wheels, pipes, novelties, bobbins, spools, etc., last and wood heel factories).

Class F. Pails and Woodenware (plates, wooden bowls, tubs, etc.).

Class G. Wood Flour Mills.

†Other Metal Working Occupancies are included under Agricultural Implements; Automobile and Bicycle Factories; Bolt, Nut and Screw Works; Electrical Appliances; Forge and Smithy; Foundries; Machine Works; Rolling, Wire and Tube Works; and Stamping and Sheet Metal Works.

**The Tanneries are classified as follows:

Class A. Sole Leather and Belting.

Class B. Upper Leather (Calfskins, Sheepskins, Morocco).

Class C. Patent Leather.

Class D. Skin Mills (Glove Leather).

## Table 5—Classification of Unsatisfactory Sprinkler Fires by Occupancy.

| | Water shut off sprinklers. | Generally defective equipment and unsprinklered portions. | Defective water supply or supplies. | Sprinkler system crippled due to freezing. | Slow operation of dry system or defective dry valve. | Slow or defective operation of high test heads. | Faulty building construction, concealed spaces, vertical openings. | Obstruction to distribution. | Hazard of occupancy too severe for average sprinkler equipment. | Sprinkler system crippled by explosion. | Exposure or conflagration. | Plugged heads. | Miscellaneous. | Total. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Abrasive Works | .. | 1 | .. | .. | .. | .. | .. | .. | .. | .. | .. | 1 | .. | 2 |
| Agricultural Implements | 4 | 1 | .. | .. | .. | .. | .. | 1 | .. | .. | .. | .. | .. | 6 |
| Alcohol Distilleries | .. | .. | .. | .. | .. | .. | .. | .. | .. | 2 | 1 | .. | .. | 3 |
| Aluminum Works | .. | .. | .. | .. | .. | .. | .. | .. | .. | 1 | .. | .. | .. | 1 |
| Amusement Places | 2 | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | 1 | .. | 3 |
| Artificial Leather Mfg. | .. | .. | .. | .. | .. | .. | 1 | .. | .. | 2 | .. | .. | .. | 3 |
| Asbestos Works | .. | .. | 2 | .. | .. | .. | .. | .. | .. | 1 | .. | .. | .. | 3 |
| Automobile and Bicycle Mfg. | 8 | 3 | 2 | .. | 1 | .. | .. | 4 | .. | 2 | 1 | .. | .. | 21 |
| Auto & Carriage Body Mfg. | 4 | 6 | 3 | .. | 2 | .. | 1 | 2 | 1 | 1 | 3 | 1 | 1 | 25 |
| Auto Sales and Service | 2 | 1 | .. | 1 | .. | .. | .. | .. | .. | 1 | .. | .. | .. | 5 |
| Bag Factories | .. | .. | .. | .. | .. | 1 | .. | 1 | .. | .. | .. | 1 | .. | 3 |
| Bakeries | 4 | 1 | .. | .. | .. | .. | 1 | .. | .. | .. | .. | .. | 2 | 8 |
| Basket Factories | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | 1 | .. | .. | 1 |
| Battery Mfg. | 2 | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | 1 | .. | 3 |
| Bolt, Nut and Screw Works | 1 | 2 | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | 3 |
| Bottling Works | .. | 1 | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | 1 |
| Braid Mills | .. | 1 | .. | .. | .. | .. | .. | 1 | .. | .. | .. | .. | .. | 2 |
| Brass and Copper Works | 1 | 1 | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | 1 | 3 |
| Broom Factories | 2 | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | 2 |
| Button Factories | .. | .. | .. | 2 | .. | .. | .. | .. | .. | .. | .. | .. | .. | 2 |
| Candy Factories | 4 | .. | .. | 1 | 1 | .. | 2 | .. | 1 | .. | 1 | .. | 1 | 11 |
| Canneries | 1 | .. | .. | .. | 1 | .. | .. | .. | .. | .. | 1 | .. | .. | 3 |
| Car Houses | 2 | 3 | 1 | .. | 1 | .. | .. | 1 | .. | .. | .. | .. | .. | 8 |
| Car Works | 2 | 1 | .. | .. | .. | .. | 1 | 1 | .. | .. | .. | .. | .. | 5 |
| Carpet and Rug Mills | 4 | 2 | 3 | .. | .. | .. | .. | 2 | .. | .. | .. | .. | .. | 11 |
| Cement and Plaster Mills | 1 | 1 | .. | .. | 1 | .. | .. | .. | .. | .. | .. | .. | .. | 3 |
| Cereal Mills | .. | 2 | 1 | .. | .. | .. | .. | 1 | .. | 4 | .. | .. | .. | 8 |
| Chemical & White Lead Wks. | 3 | 5 | .. | .. | .. | .. | .. | .. | 5 | 8 | .. | .. | 1 | 22 |
| Clothing Mfg. | 6 | 2 | 2 | 1 | .. | .. | 4 | 2 | .. | .. | 1 | 1 | 1 | 20 |
| Clubs—City | .. | .. | .. | .. | .. | .. | 1 | .. | .. | .. | .. | .. | .. | 1 |
| Coffee and Spice Mills | 2 | .. | .. | .. | .. | .. | .. | 1 | .. | 1 | .. | .. | .. | 4 |
| Coffin and Casket Mfg. | 2 | .. | .. | 1 | 1 | .. | 1 | .. | .. | .. | .. | .. | .. | 5 |
| Cooperage Plants | 1 | 4 | .. | .. | .. | 1 | .. | 4 | .. | .. | 2 | .. | .. | 12 |
| Cordage Works | 5 | 4 | 1 | 1 | .. | .. | .. | 2 | .. | .. | .. | .. | 1 | 14 |
| Cork Factories | 1 | .. | 1 | .. | .. | .. | .. | .. | 1 | 1 | .. | .. | 1 | 5 |
| Cotton Gins | 1 | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | 1 |
| Cotton Mills | 40 | 27 | 11 | 2 | 2 | 1 | 5 | 3 | 3 | 1 | .. | 4 | 15 | 114 |
| Cotton Seed Oil Mills | 3 | 6 | 3 | .. | .. | .. | .. | .. | 2 | .. | .. | .. | 3 | 17 |
| Cotton Warehouses | 15 | 2 | 4 | .. | 2 | .. | 1 | 6 | 4 | .. | .. | 2 | 4 | 40 |
| Cutlery Mfg. | 1 | 1 | 1 | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | 3 |
| Department Stores | 9 | 3 | 1 | .. | 2 | .. | 1 | 2 | .. | .. | 2 | .. | 1 | 21 |
| Drug Mfg. and Warehouses | 1 | .. | .. | .. | 1 | .. | .. | .. | .. | .. | 3 | .. | 1 | 6 |
| Dry Goods Stores | 4 | .. | .. | .. | .. | .. | .. | 1 | .. | .. | .. | .. | .. | 5 |
| Dwellings | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | 1 | 1 |
| Dyeing, Bleaching, Finishing | 7 | 3 | 1 | .. | 1 | 1 | .. | 2 | .. | .. | 1 | 1 | 1 | 18 |
| Electrical Appliance Mfg. | 3 | .. | 2 | .. | .. | .. | 1 | 2 | .. | 1 | .. | 1 | 3 | 13 |
| Electric Power and Light | 1 | 1 | .. | .. | .. | .. | .. | 1 | .. | .. | .. | .. | .. | 3 |

| | Water shut off sprinklers. | Generally defective equipment and unsprinklered portions. | Defective water supply or supplies. | Sprinkler system crippled due to freezing. | Slow operation of dry system or defective dry valve. | Slow or defective operation of high test heads. | Faulty building construction, concealed spaces, vertical openings. | Obstruction to distribution. | Hazard of occupancy too severe for average sprinkler equipment. | Sprinkler system crippled by explosion. | Exposure or conflagration. | Plugged heads. | Miscellaneous. | Total. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Excelsior Factories | .. | .. | 2 | .. | 1 | .. | .. | .. | 1 | .. | .. | .. | .. | 4 |
| Fertilizer Plants | 2 | 1 | .. | .. | 1 | .. | .. | .. | .. | .. | .. | .. | .. | 4 |
| Fiber Products | .. | .. | 1 | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | 1 |
| Flour and Grist Mills | 8 | 3 | 2 | .. | 1 | .. | 1 | 1 | 2 | 6 | 2 | .. | 2 | 28 |
| Forge and Smithy | .. | .. | .. | .. | .. | .. | .. | 1 | .. | .. | .. | 1 | .. | 2 |
| Foundries | 12 | 1 | 1 | .. | 1 | .. | 1 | .. | .. | 2 | .. | .. | .. | 18 |
| Fur Works | 1 | .. | .. | .. | .. | .. | 2 | .. | .. | .. | .. | .. | 1 | 4 |
| Furniture Factories | 32 | 21 | 8 | 4 | 1 | .. | 4 | 12 | 11 | 1 | 4 | 2 | 2 | 102 |
| Furniture Stores | 5 | .. | .. | .. | 1 | .. | 1 | .. | .. | .. | .. | .. | .. | 7 |
| Garages | 11 | .. | .. | 2 | 1 | .. | .. | 3 | .. | 1 | .. | .. | 1 | 19 |
| Garbage Reduction Plants | 1 | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | 1 |
| Gas Works | .. | 1 | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | 1 |
| Glass Factories | 4 | 3 | 2 | 1 | .. | .. | 3 | 1 | .. | .. | .. | .. | 3 | 17 |
| Glove Factories | 1 | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | 1 |
| Glue Factories | 2 | .. | .. | .. | .. | .. | .. | .. | 1 | .. | .. | .. | .. | 3 |
| Grain Elevators | 1 | 5 | 5 | .. | 4 | .. | 2 | 1 | 1 | 4 | 2 | .. | 1 | 26 |
| Groceries | 5 | .. | 1 | .. | 1 | .. | 1 | .. | 1 | 1 | .. | .. | .. | 10 |
| Hardware Stores | 2 | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | 1 | 3 |
| Hat Factories | 8 | 4 | 2 | .. | 1 | .. | .. | 2 | .. | .. | .. | .. | 3 | 20 |
| Hotels—Year Round | 1 | 1 | 1 | .. | .. | .. | 1 | .. | .. | .. | .. | .. | .. | 4 |
| Hotels—Seasonal | .. | .. | .. | .. | .. | .. | 1 | .. | .. | .. | .. | .. | .. | 1 |
| Ice Houses | 1 | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | 1 |
| Idle and Vacant Property | 14 | 1 | .. | 2 | .. | .. | 1 | 1 | .. | .. | .. | 1 | .. | 20 |
| Insulated Wire Works | .. | 2 | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | 2 |
| Jewelry Factories | 3 | 1 | .. | 2 | .. | .. | 1 | .. | .. | .. | .. | .. | .. | 7 |
| Junk Shops | 1 | .. | .. | .. | .. | .. | .. | .. | .. | .. | 1 | .. | .. | 2 |
| Knitting Mills—Cop Yarn | 1 | 1 | 3 | .. | .. | .. | .. | 1 | .. | 1 | .. | .. | .. | 7 |
| Knitting Mills—Full Process | 9 | 10 | 6 | 1 | 1 | .. | 1 | .. | .. | 1 | .. | .. | .. | 29 |
| Lamp Shade Factories | .. | .. | 1 | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | 1 |
| Laundries | 4 | .. | 1 | .. | .. | .. | .. | 1 | .. | .. | .. | .. | .. | 6 |
| Lead Pencil Factories | .. | .. | .. | .. | .. | .. | .. | .. | .. | 1 | .. | .. | .. | 1 |
| Leather Working | 1 | .. | 1 | .. | 1 | .. | .. | 1 | .. | .. | .. | .. | 1 | 5 |
| Linoleum Works | .. | 8 | .. | .. | .. | .. | 1 | 2 | 7 | .. | .. | .. | .. | 18 |
| Linseed Oil Works | 1 | 1 | .. | .. | .. | .. | 1 | .. | 1 | 2 | .. | 2 | .. | 8 |
| Macaroni Factories | 2 | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | 2 |
| Machine Shops and Works | 17 | 6 | 1 | 1 | .. | 1 | .. | .. | .. | 2 | .. | 2 | .. | 30 |
| Match Factories | 2 | .. | .. | .. | .. | .. | .. | .. | 2 | .. | .. | .. | 1 | 5 |
| Mattress Factories | 12 | 2 | .. | 1 | .. | .. | .. | 2 | .. | .. | .. | .. | .. | 17 |
| Mercantile (Miscellaneous) | 10 | 6 | 1 | 2 | .. | .. | 5 | .. | .. | .. | 4 | .. | 2 | 30 |
| Metal Workers† | 25 | 20 | 4 | 1 | 1 | 2 | 5 | 3 | 6 | 5 | 3 | 2 | 4 | 81 |
| Mining Property | .. | 1 | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | 1 |
| Miscellaneous | 4 | 4 | 1 | .. | 1 | 1 | 3 | .. | 6 | 1 | 2 | .. | 4 | 27 |
| Motion Picture Exchanges | .. | .. | .. | .. | 1 | .. | .. | .. | 2 | .. | .. | .. | .. | 3 |
| Motion Picture Theatres | 2 | 1 | .. | .. | .. | .. | 1 | .. | 1 | 1 | 1 | .. | .. | 6 |
| Multiple Occupancy | 2 | 1 | .. | 1 | .. | .. | 5 | .. | .. | 2 | .. | .. | 1 | 12 |
| Munition Plants | 2 | .. | .. | 1 | .. | .. | .. | .. | 4 | 1 | .. | .. | 1 | 9 |
| Musical Instrum't Factories | 1 | 4 | .. | .. | .. | .. | 1 | .. | .. | .. | 1 | .. | .. | 7 |
| Oil Cloth Works | .. | .. | .. | .. | .. | .. | .. | 1 | 6 | .. | .. | .. | .. | 7 |
| Oil Clothing Factories | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | 1 | 1 |

| | Water shut off sprinklers. | Generally defective equipment and unsprinklered portions. | Defective water supply or supplies. | Sprinkler system crippled due to freezing. | Slow operation of dry system or defective dry valve. | Slow or defective operation of high test heads. | Faulty building construction, concealed spaces, vertical openings. | Obstruction to distribution. | Hazard of occupancy too severe for average sprinkler equipment. | Sprinkler system crippled by explosion. | Exposure or conflagration. | Plugged heads. | Miscellaneous. | Total. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Oil Refineries—Vegetable... | 2 | .. | 2 | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | 4 |
| Packing Houses..... | 3 | 2 | 1 | .. | 2 | .. | .. | .. | 1 | 1 | .. | .. | 1 | 11 |
| Paint and Varnish Works.. | 3 | 3 | 5 | .. | 1 | .. | 3 | 1 | .. | 2 | .. | .. | .. | 18 |
| Paper Coating Mills..... | 1 | .. | .. | .. | .. | .. | .. | 2 | .. | .. | .. | .. | 1 | 4 |
| Paper Mills..... | 27 | 25 | 17 | 3 | 2 | 3 | 2 | 8 | 4 | 3 | 2 | 2 | 14 | 112 |
| Paper Working..... | 6 | 1 | .. | .. | 1 | .. | .. | 2 | .. | .. | .. | 1 | .. | 11 |
| Peanut Roasting Plants.... | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | 2 | .. | .. | 2 |
| Phonograph Works..... | 1 | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | 1 |
| Photographic Establishments | 1 | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | 1 |
| Picture Frame Mfg..... | 1 | 2 | 1 | 1 | .. | .. | .. | 1 | .. | .. | .. | .. | .. | 6 |
| Piers and Wharves..... | .. | 2 | 1 | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | 3 |
| Plumbers' Supplies..... | 2 | 1 | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | 3 |
| Potteries ..... | 3 | 2 | 1 | 1 | .. | .. | .. | .. | .. | 1 | .. | .. | .. | 8 |
| Printing and Lithographing | 10 | 5 | 1 | .. | .. | .. | 2 | 1 | 1 | .. | 3 | .. | 1 | 24 |
| Prisons ..... | .. | .. | .. | .. | 1 | .. | .. | .. | 1 | .. | .. | .. | .. | 2 |
| Pulp Mills..... | 10 | 4 | 4 | .. | 1 | 1 | 1 | .. | 1 | 1 | .. | .. | 2 | 25 |
| Pyroxylin Plastic Mfg. and Fabricating ..... | 3 | 1 | 3 | 1 | 1 | .. | 2 | 2 | 13 | 5 | 2 | .. | .. | 33 |
| Radios and Accessories..... | 1 | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | 1 | .. | 2 |
| Railroad—Misc. Property... | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | 1 | .. | 1 |
| Rayon Mills..... | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | 1 | 1 |
| Restaurants ..... | 1 | 1 | .. | .. | .. | .. | 1 | .. | .. | .. | .. | .. | .. | 3 |
| Rice Mills..... | .. | 1 | 1 | .. | .. | .. | .. | .. | .. | .. | .. | .. | 2 | 4 |
| Rolling, Wire & Tube Mills | .. | 1 | .. | .. | 1 | 1 | 1 | .. | .. | .. | .. | 1 | .. | 5 |
| Roofing Works..... | 3 | 2 | .. | 1 | .. | .. | 1 | 2 | .. | 1 | .. | .. | .. | 10 |
| Rooming & Lodging Houses | 1 | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | 1 |
| Rubber Cloth Factories.... | 2 | 1 | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | 1 | 4 |
| Rubber Reclaiming Works.. | 3 | .. | .. | .. | .. | .. | 1 | 1 | 1 | 1 | 1 | .. | .. | 8 |
| Rubber Mills..... | 9 | 1 | .. | 1 | .. | .. | .. | 1 | 7 | 5 | .. | 1 | 1 | 26 |
| Saw and Planing Mills..... | 16 | 14 | 7 | .. | 5 | 1 | 6 | 4 | 8 | .. | 5 | 1 | 5 | 72 |
| Schools—Private ..... | .. | 1 | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | 1 |
| Schools—Public ..... | .. | .. | .. | .. | .. | .. | 1 | .. | .. | .. | .. | .. | .. | 1 |
| Schools—Trade & Industrial | 1 | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | 1 |
| Shipyards ..... | 1 | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | 1 |
| Shoddy Mills..... | 6 | 3 | 7 | .. | 1 | 3 | 1 | 1 | .. | .. | .. | .. | 1 | 23 |
| Shoe Factories..... | 19 | 8 | 3 | .. | 1 | 1 | 2 | 3 | .. | 3 | 5 | .. | 3 | 48 |
| Shoe Mfg. Accessories..... | 3 | 2 | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | 1 | 6 |
| Silk Mills..... | 3 | 2 | .. | .. | .. | .. | .. | .. | .. | 1 | .. | .. | 2 | 8 |
| Soap Manufacturing..... | 2 | 1 | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | 3 |
| Stamping & Sht.Metal Wks. | 4 | 5 | 1 | .. | 1 | .. | 2 | 1 | .. | 1 | 2 | .. | 1 | 18 |
| Starch and Glucose Works.. | .. | .. | .. | .. | .. | .. | .. | .. | 1 | 7 | .. | .. | .. | 8 |
| Sugar Refineries..... | 1 | 1 | .. | .. | .. | .. | .. | .. | .. | 1 | .. | .. | .. | 3 |
| Tannery Class A**..... | .. | 1 | .. | 1 | .. | .. | .. | .. | .. | .. | 1 | .. | 1 | 4 |
| Tannery Class B**..... | 7 | 4 | .. | 2 | 3 | .. | 1 | 1 | .. | .. | .. | .. | 1 | 19 |
| Tannery Class C**..... | 1 | .. | 1 | 1 | .. | .. | 1 | .. | .. | .. | 1 | .. | .. | 5 |
| Tannery Class D**..... | .. | .. | .. | 1 | .. | .. | .. | .. | .. | .. | .. | .. | .. | 1 |
| Tenant Manufacturing..... | 46 | 8 | 2 | 3 | 1 | .. | 3 | 2 | 2 | 1 | 7 | 2 | 3 | 80 |
| Theatres ..... | 4 | 3 | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | 7 |
| Tobacco Factories..... | 1 | 1 | .. | .. | .. | .. | .. | .. | 1 | .. | 1 | .. | .. | 4 |

| | Water shut off sprinklers. | Generally defective equipment and unsprinklered portions. | Defective water supply or supplies. | Sprinkler system crippled due to freezing. | Slow operation of dry system or defective dry valve. | Slow or defective operation of high test heads. | Faulty building construction, concealed spaces, vertical openings. | Obstruction to distribution. | Hazard of occupancy too severe for average sprinkler equipment. | Sprinkler system crippled by explosion. | Exposure or conflagration. | Plugged heads. | Miscellaneous. | Total. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Trunk Factories | 3 | 1 | 1 | .. | .. | .. | 1 | .. | .. | .. | 1 | .. | .. | 7 |
| Umbrella Mfg. | .. | .. | .. | .. | .. | .. | .. | .. | .. | 1 | .. | .. | .. | 1 |
| Wall Paper Factories | .. | .. | 1 | .. | .. | .. | .. | 1 | 1 | .. | 1 | .. | .. | 4 |
| Warehouses | 20 | 7 | 4 | .. | 3 | .. | 3 | 5 | 5 | .. | .. | .. | 4 | 51 |
| Waste and Batting Mills | 8 | 4 | 5 | 2 | 2 | 1 | .. | 2 | 2 | .. | .. | 2 | 1 | 29 |
| Waste Paper & Rag Sorting | 9 | 2 | 1 | .. | .. | .. | .. | .. | .. | .. | .. | .. | 2 | 14 |
| Weaving Mills | 1 | 2 | 2 | 1 | .. | .. | .. | 1 | .. | .. | .. | .. | .. | 7 |
| Window Shade Factories | .. | .. | .. | 1 | .. | .. | .. | .. | 1 | .. | .. | .. | .. | 2 |
| Woodworker Class A* | 13 | 10 | 5 | 1 | 1 | 1 | 2 | 6 | 1 | 3 | 3 | 1 | 4 | 51 |
| Woodworker Class B* | 9 | 9 | 3 | 2 | 1 | 2 | 1 | 1 | .. | 3 | 2 | 3 | .. | 36 |
| Woodworker Class C* | 6 | 6 | 3 | .. | .. | .. | 1 | 3 | .. | .. | .. | .. | .. | 19 |
| Woodworker Class D* | 2 | 10 | .. | 1 | 1 | .. | .. | .. | .. | 2 | 4 | .. | 3 | 23 |
| Woodworker Class E* | 6 | 2 | 1 | .. | 2 | 1 | 2 | .. | 1 | .. | 1 | .. | .. | 16 |
| Woodworker Class F* | 2 | .. | 1 | .. | .. | .. | .. | 1 | .. | .. | .. | .. | .. | 4 |
| Woodworker Class G* | .. | .. | .. | .. | .. | .. | .. | .. | .. | 1 | .. | .. | .. | 1 |
| Woolen Mills | 21 | 20 | 14 | 1 | .. | 2 | 4 | 1 | 1 | .. | 3 | .. | 9 | 76 |
| Wool Scouring Plants | .. | 1 | 1 | .. | .. | .. | 1 | .. | .. | .. | .. | .. | .. | 3 |
| Wool Storehouses | .. | 2 | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | 1 | 3 |
| Worsted Mills | 3 | 3 | 2 | 1 | .. | .. | 1 | .. | .. | .. | .. | .. | 4 | 14 |
| Total | 670 | 381 | 186 | 54 | 66 | 25 | 108 | 128 | 121 | 102 | 84 | 39 | 138 | 2102 |

†See note on Metal Workers under Table No. 4.
*See detailed classification of Woodworkers as given in note under Table No. 4.
**See detailed classification of Tanneries as given in note under Table No. 4.

# VOLUME XXVI. INDEX.


| A | Quarterly No. | Page No. |
|---|---|---|
| Amsterdam, Holland, M. S. Pieter Corneliszoon Hooft Fire. *L. J. E. van Steenwijk* | 3 | 250 |
| Armory Fires, Baltimore. *R. W. Neal and C. V. Gordon* | 4 | 351 |
| Apartment Fire, Ellington, Cleveland | 1 | 62 |
| Arson, The Control of. *George W. Smith* | 2 | 113 |
| Auburn, N. Y., Church and Masonic Building Fire | 2 | 171 |
| Automatic Sprinklers, Annual Tables | 4 | 371 |
| **B** | | |
| Bad Fire Records, Direct Cost of | 1 | 46 |
| Baltimore Armory Fires. *R. W. Neal and C. V. Gordon* | 4 | 351 |
| Beaver, Pa., Courthouse Fire. *William E. Patterson* | 1 | 58 |
| Board of Directors' Action | 2 | 112 |
| Board of Directors Meetings: | | |
| May 10, 1932 | 1 | 9 |
| June 13, 1932 | 1 | 9 |
| Jan. 14, 1933 | 4 | 299 |
| Bremo Bluff, Va., Power Plant Fire. *South-Eastern Underwriters Association* | 2 | 151 |
| Brewery Fire Record | 4 | 358 |
| Brigham City, Utah. Sugar Warehouse Fire. *A. J. Snow* | 3 | 253 |
| Bus Garage Explosion and Fire, St. Louis, Missouri. *St. Louis Fire Prevention Bureau* | 2 | 163 |
| **C** | | |
| California Earthquake of March 10, 1933 | 4 | 319 |
| Canadian Fire Losses, 1931. *Dominion Fire Protection Association* | 1 | 26 |
| Century of Progress Exhibition, Chicago. *John A. Neale* | 4 | 303 |
| *Editorial* | 4 | 295 |
| Cigarette Fires. *Editorial* | 4 | 296 |
| Chicago Elevator and Packing House Fire. *Chicago Board of Fire Underwriters* | 2 | 157 |
| Church and Masonic Building Fire, Auburn, N. Y. | 2 | 171 |
| Cincinnati's Clean-Up Inspections | 3 | 216 |
| Cleaning Floors with Gasoline. *Editorial* | 2 | 109 |
| Clean-Up Inspections, Cincinnati | 3 | 216 |
| Cleveland, O., Ellington Apartments Fire | 1 | 62 |
| Columbus, O., State Office Building Explosion. *Engineering News-Record* | 1 | 55 |
| Coney Island Conflagration, New York. *New York Board of Fire Underwriters* | 2 | 129 |
| Control of Incendiarism. *George W. Smith* | 2 | 113 |
| Co-ordinating Municipal Fire Prevention Effort, San Francisco. *Thomas Larke, Jr.* | 2 | 121 |
| Cost of Bad Fire Records | 1 | 46 |
| Cost of Fire Safety. *Editorial* | 2 | 105 |
| Cost of Fire, The Total. *Editorial* | 3 | 199 |
| Courthouse Fire, Beaver, Pa. *William E. Patterson* | 1 | 58 |
| Cunard Steamship Pier Fire, New York. *New York Board of Fire Underwriters* | 1 | 48 |
| **D** | | |
| Deflation and Fire Protection. *Editorial* | 1 | 5 |
| Department Store Fire, Tokyo, Japan | 3 | 214 |
| Detroit Pulpwood Fire. *Western Factory Insurance Association* | 1 | 80 |
| Discovery and Removal of Pipe Obstructions. *A. L. Brown* | 1 | 29 |
| Drydock and Tanker Explosion, Montreal | 1 | 60 |
| Dry Goods Stores, Fire Record of | 2 | 177 |
| Dust Explosion Hazard | 4 | 363 |
| Dust Explosions, Venting. *Hylton R. Brown and Richard L. Hanson* | 4 | 328 |
| **E** | | |
| Earthquake, Southern California, March 10, 1933 | 4 | 319 |
| Editorials | 1 | 5 |
| | 2 | 105 |
| | 3 | 199 |
| | 4 | 295 |
| Electrical Economies, Hazard of. *Editorial* | 2 | 106 |
| Elevator and Packing House Fire, Chicago. *Chicago Board of Fire Underwriters* | 2 | 157 |
| Ellington Apartments Fire, Cleveland, O. | 1 | 62 |
| Estimating Losses and Determining Values. *A. G. Smith* | 4 | 314 |
| Exhibit of Indianapolis Fire Dept. at State Fair | 2 | 111 |
| Exhibition, A Century of Progress, Chicago. *John A. Neale* | 4 | 303 |
| Exits, A Survey of. *Harry B. Houghton and John H. Courtney* | 3 | 234 |
| Explosion and Fire, St. Louis Bus Garage. *St. Louis Fire Prevention Bureau* | 2 | 163 |
| Explosion, Dry Dock and Tanker, Montreal | 1 | 60 |
| Explosion, Gas Holder, Neunkirchen, Germany | 4 | 364 |
| Explosion, State Office Building, Columbus, O. *Engineering News-Record* | 1 | 55 |
| Explosions in Sewage Disposal Plants. *R. M. Cadman* | 1 | 35 |

| F | Quarterly No. | Page No. |
|---|---|---|
| Fair, A Century of Progress, Chicago. *John A. Neale* | 4 | 303 |
| Field Service Program, A Measure of Success. *Editorial* | 1 | 8 |
| Film Cabinets, Nitrocellulose, Tests on. *A. J. Steiner* | 2 | 143 |
| Film Fires, Nitrocellulose. *Editorial* | 2 | 108 |
| Fire Alarm System, Portland, Oregon. *C. C. Ralph* | 1 | 40 |
| Fire Department | | |
| Los Angeles | 1 | 14 |
| Technical Men for. *Editorial* | 3 | 200 |
| Fire Loss, U. S. 1931. *National Board of Fire Underwriters* | 1 | 20 |
| Fire Loss, U. S. 1932. *Editorial* | 3 | 199 |
| Fire Loss, U. S. 1932. *National Board of Fire Underwriters* | 3 | 208 |
| Fire Losses, U. S. 1931 and 1932. *National Board of Fire Underwriters* | 4 | 312 |
| Fire Losses, Canadian, 1931. *Dominion Fire Prevention Association* | 1 | 26 |
| Fire Losses, Comparative | 1 | 28 |
| Fire Losses, Great Britain and Ireland | 1 | 28 |
| Fire Prevention, Co-ordinating Municipal Effort, San Francisco. *Thomas J. Larke, Jr.* | 2 | 121 |
| Fire Prevention Exhibit of Indianapolis Fire Dept. at State Fair | 2 | 111 |
| Fire Prevention Week 1932. *Editorial* | 2 | 106 |
| Fire Protection, What We Pay for. *George W. Booth* | 3 | 205 |
| Fire Record—Pulpwood Piles | 1 | 86 |
| —Mercantiles | 2 | 172 |
| —Dry Goods Stores | 2 | 177 |
| —Furniture Stores | 2 | 179 |
| —Grocery Stores | 2 | 181 |
| —General Stores | 2 | 183 |
| —Hardware Stores | 2 | 185 |
| —Miscellaneous Mercantile Stores | 2 | 188 |
| —Fire-Resistive Buildings | 3 | 258 |
| —Range Oil Burners | 4 | 342 |
| —Breweries | 4 | 358 |
| Fire Records (Bad), Direct Cost of | 1 | 46 |
| Fire-Resistive Buildings Fires | 3 | 258 |
| Floors, Cleaning with Gasoline. *Editorial* | 2 | 109 |
| Forest Fire Equipment Demonstration, Stephentown, N. Y. Authorization by Board of Directors | 2 | 112 |
| *N.F.P.A. Forest Committee* | 3 | 227 |
| Furniture Stores, Fire Record of | 2 | 179 |

| G | Quarterly No. | Page No. |
|---|---|---|
| Garage, Bus, Explosion and Fire. *St. Louis Fire Prevention Bureau* | 2 | 163 |
| Garages, Approval of Changes in Regulations | 2 | 112 |
| Gas Holder Explosion, Neunkirchen, Germany | 4 | 364 |
| Gasoline, Floor Cleaning. *Editorial* | 2 | 109 |
| General Stores, Fire Record of | 2 | 183 |
| Grain Elevator Fire, Quincy, Chicago. *Chicago Board of Underwriters* | 2 | 157 |
| Great Britain and Ireland, Fire Losses | 1 | 28 |
| Grocery Stores, Fire Record of | 2 | 181 |

| H | Quarterly No. | Page No. |
|---|---|---|
| Hardware Stores, Fire Record of | 2 | 185 |
| Hazard of Electrical Economies. *Editorial* | 2 | 106 |
| High School Fire, Little Rock, Ark. *George D. Suter* | 3 | 247 |

| I | Quarterly No. | Page No. |
|---|---|---|
| Incendiarism, The Control of. *George W. Smith* | 2 | 113 |
| Indianapolis Fire Dept. Exhibit at State Fair | 2 | 111 |
| Insurance Inspection, A New Type of. *Editorial* | 1 | 7 |

| L | Quarterly No. | Page No. |
|---|---|---|
| Large Loss Fires, 1932 | 3 | 209 |
| Liability for Fire Loss. *Decision of Supreme Court of Canada* | 1 | 13 |
| Little Rock, Ark., High School Fire. *George D. Suter* | 3 | 247 |
| Los Angeles Fire Department | 1 | 14 |
| Loss Estimating and Determining Values. *A. G. Smith* | 4 | 314 |
| Loss of Life Fires | 1 | 97 |
| | 2 | 191 |
| | 3 | 287 |
| | 4 | 368 |
| Losses, Fire. (*See Fire Losses.*) | | |

| M | Quarterly No. | Page No. |
|---|---|---|
| Marine Fires: | | |
| M. S. Pieter Corneliszoon Hooft. *L. J. E. van Steenwijk* | 3 | 250 |
| Ship Fires Continue. *Editorial* | 3 | 202 |
| Mercantile Fire Record | 2 | 172 |
| Miscellaneous Mercantile Stores, Fire Record of | 2 | 188 |
| Montreal, Explosion, Dry Dock and Tanker | 1 | 60 |
| Municipal Expenditures, Reduction of. *City Managers' Association* | 3 | 203 |
| Municipal Fire Prevention Effort, Co-ordinating. *Thomas Larke, Jr.* | 2 | 121 |
| Municipal Fire Protection Costs. *George W. Booth* | 3 | 205 |

| N | Quarterly No. | Page No. |
|---|---|---|
| Neunkirchen, Germany, Gas Holder Explosion | 4 | 364 |
| New York, Coney Island Conflagration. *New York Board of Fire Underwriters* | 2 | 129 |

| | Quarterly No. | Page No. |
|---|---|---|
| New York, Cunard Steamship Pier Fire. *New York Board of Fire Underwriters* | 1 | 48 |
| Nitrocellulose Film Cabinets, Tests of. *A. J. Steiner* | 2 | 143 |
| Nitrocellulose Film Fires. *Editorial* | 2 | 108 |

**O**

| | | |
|---|---|---|
| Office Building Explosion, State, Columbus, O. *Engineering News-Record* | 1 | 55 |
| Oil Burners, Range, Fire Record | 4 | 342 |
| Oil Fire, St. Paul. *John Townsend* | 2 | 165 |

**P**

| | | |
|---|---|---|
| Pier Fire, Cunard Steampship. *New York Board of Fire Underwriters* | 1 | 48 |
| Pipe Obstructions, Discovery and Removal of. *A. L. Brown* | 1 | 29 |
| Port Alfred, P. Q., Pulpwood Fire. *Canadian Fire Underwriters Association* | 1 | 63 |
| Portland, Oregon, Fire Alarm System. *C. C. Ralph* | 1 | 40 |
| Power Plant Fire, Bremo Bluff, Va. *South-Eastern Underwriters Association* | 2 | 151 |
| Private Fire Brigade Results. *Editorial* | 4 | 297 |
| Public Building Fires: | | |
| Courthouse Fire, Beaver, Pa. | 1 | 58 |
| State Office Building Explosion | 1 | 55 |
| Baltimore Armory Fires | 4 | 351 |
| Pulpwood Fire, Detroit, Mich. *Western Factory Insurance Association* | 1 | 80 |
| Port Alfred, Quebec | 1 | 63 |
| Pulpwood Piles, Fire Record | 1 | 86 |

**R**

| | | |
|---|---|---|
| Racine, Wis., Investment Building Fire. *Frank R. Daniel* | 3 | 244 |
| Range Oil Burners, Fire Record | 4 | 342 |
| Reduction of Municipal Expenditures. *City Managers' Association* | 3 | 203 |

**S**

| | | |
|---|---|---|
| San Francisco, Co-ordinating Municipal Fire Prevention Effort. *Thomas Larke, Jr.* | 2 | 121 |
| San Francisco Progresses. *Editorial* | 3 | 201 |
| Sewage Disposal Plants, Explosions in. *R. M. Cadman* | 1 | 35 |
| Ship Fires Continue. *Editorial* | 3 | 202 |
| Ship Fire, M. S. Pieter Corneliszoon Hooft | 3 | 250 |
| Shoe Stores, Fire Record of | 2 | 187 |
| Small Town Fire Problem, The. *Editorial* | 3 | 202 |
| Southern California Earthquake of March 10, 1933 | 4 | 319 |
| Sprinkler Tables, Annual | 4 | 371 |
| St. Louis Bus Garage Explosion and Fire. *St. Louis Fire Prevention Bureau* | 2 | 163 |
| St. Paul, Minnesota, Superior Refining Co. Fire. *John Townsend* | 2 | 165 |
| State Office Building Explosion, Columbia, O. *Engineering News-Record* | 1 | 55 |
| Stephentown, N. Y., Demonstration of Forest Fire Equipment. *N.F.P.A. Forest Committee* | 3 | 227 |
| Sugar Warehouse Fire, Brigham City, Utah. *A. J. Snow* | 3 | 253 |
| Superior Refining Company Fire, St. Paul. *John Townsend* | 2 | 165 |
| Survey of Exits. *Harry B. Houghton and John H. Courtney* | 3 | 234 |

**T**

| | | |
|---|---|---|
| Technical Men for the Fire Department. *Editorial* | 3 | 200 |
| Tests on Nitrocellulose Film Cabinets. *A. J. Steiner* | 2 | 143 |
| Tokyo Department Store Fire | 3 | 214 |
| Total Cost of Fire. *Editorial* | 3 | 199 |
| Typical Small Town? | 3 | 224 |

**U**

| | | |
|---|---|---|
| U. S. Fire Loss, 1931. *National Board of Fire Underwriters* | 1 | 20 |
| U. S. Fire Loss, 1932. *National Board of Fire Underwriters* | 3 | 208 |
| U. S. Fire Losses, 1931 and 1932. *National Board of Fire Underwriters* | 4 | 312 |

**V**

| | | |
|---|---|---|
| Venting Dust Explosions. *Hylton R. Brown and Richard L. Hanson* | 4 | 328 |

**W**

| | | |
|---|---|---|
| What We Pay for Fire Protection. *George W. Booth* | 3 | 205 |
| Wooden Shingles Burn. *Editorial* | 1 | 6 |

**Y**

| | | |
|---|---|---|
| Youngstown Sheet and Tube Co. Fire Brigade's Results. *Editorial* | 4 | 297 |